



GPM: UK perspectives

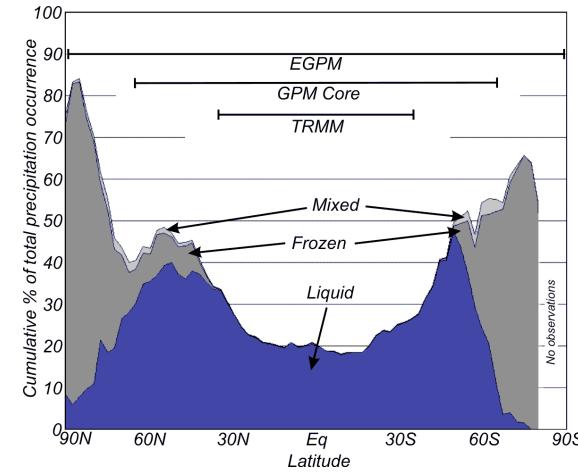
Chris Kidd¹ et al.

*¹School of Geography, Earth and Environmental Science
The University of Birmingham*

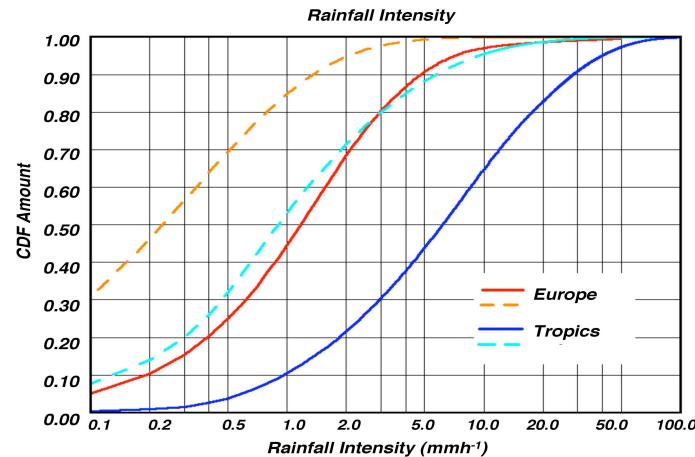


Zonal distribution of light precipitation

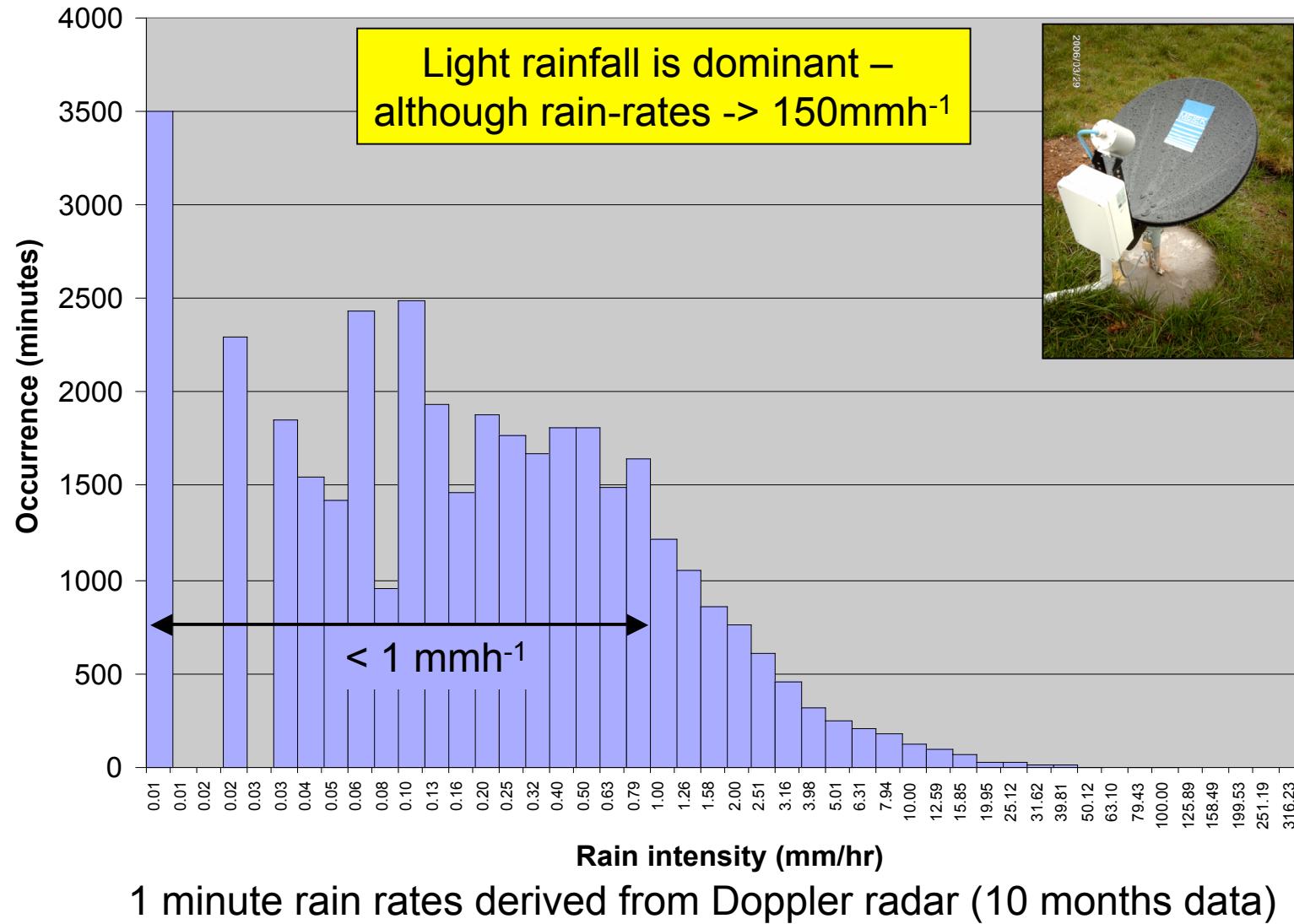
- Light rainfall becomes increasingly important towards the polar regions
- COADS data shows light precipitation occurrence >80%; ~50% in mid-latitudes



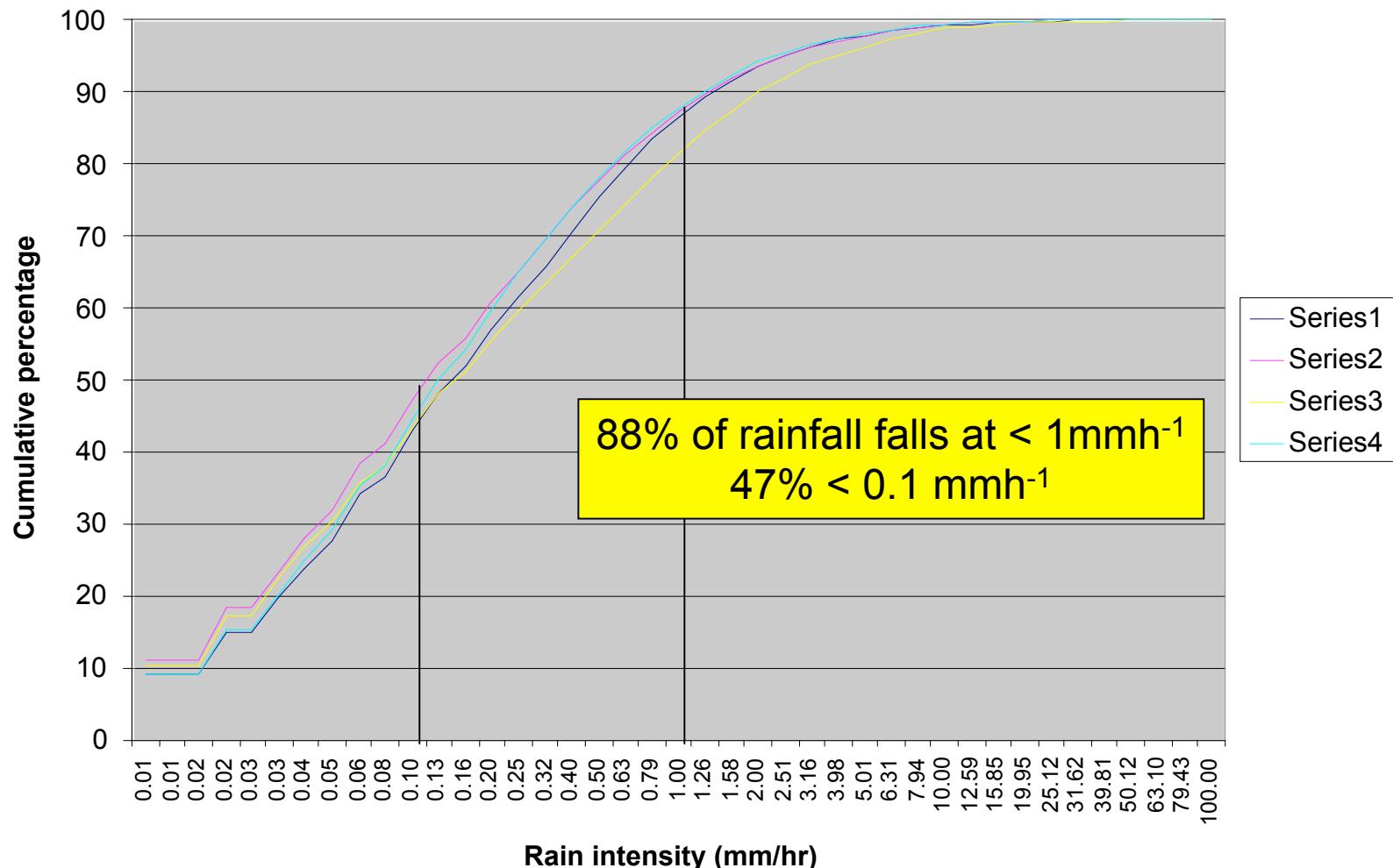
- European radar suggests ~85% of precipitation $<1 \text{ mmh}^{-1}$ ($35\% < 0.1 \text{ mmh}^{-1}$)
- Accumulation of light precipitation is small however... particularly in the Tropics



Rainfall occurrence (Bham)

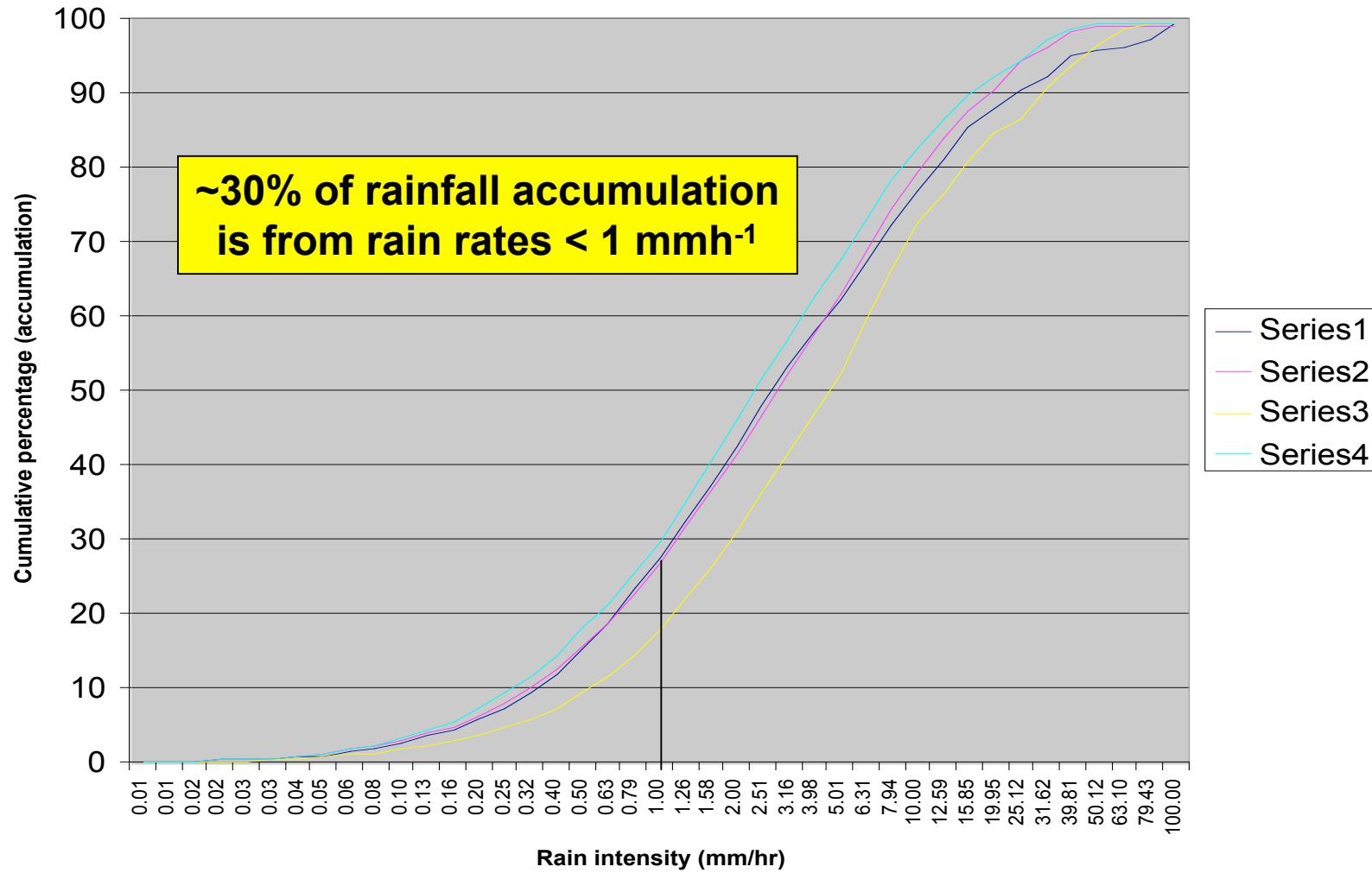


Rainfall occurrence



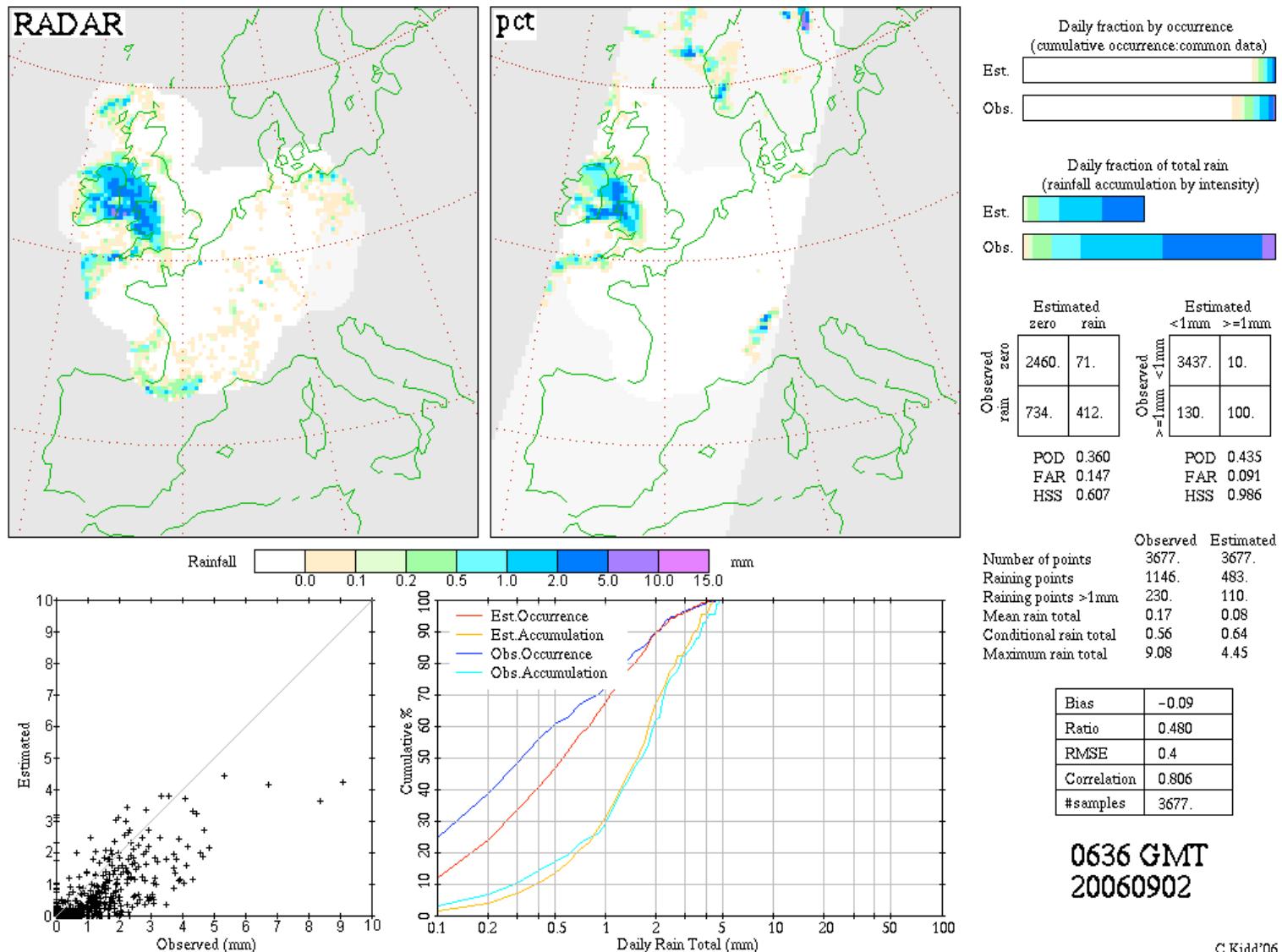
1 minute rain rates derived from Doppler radar

Rainfall accumulation

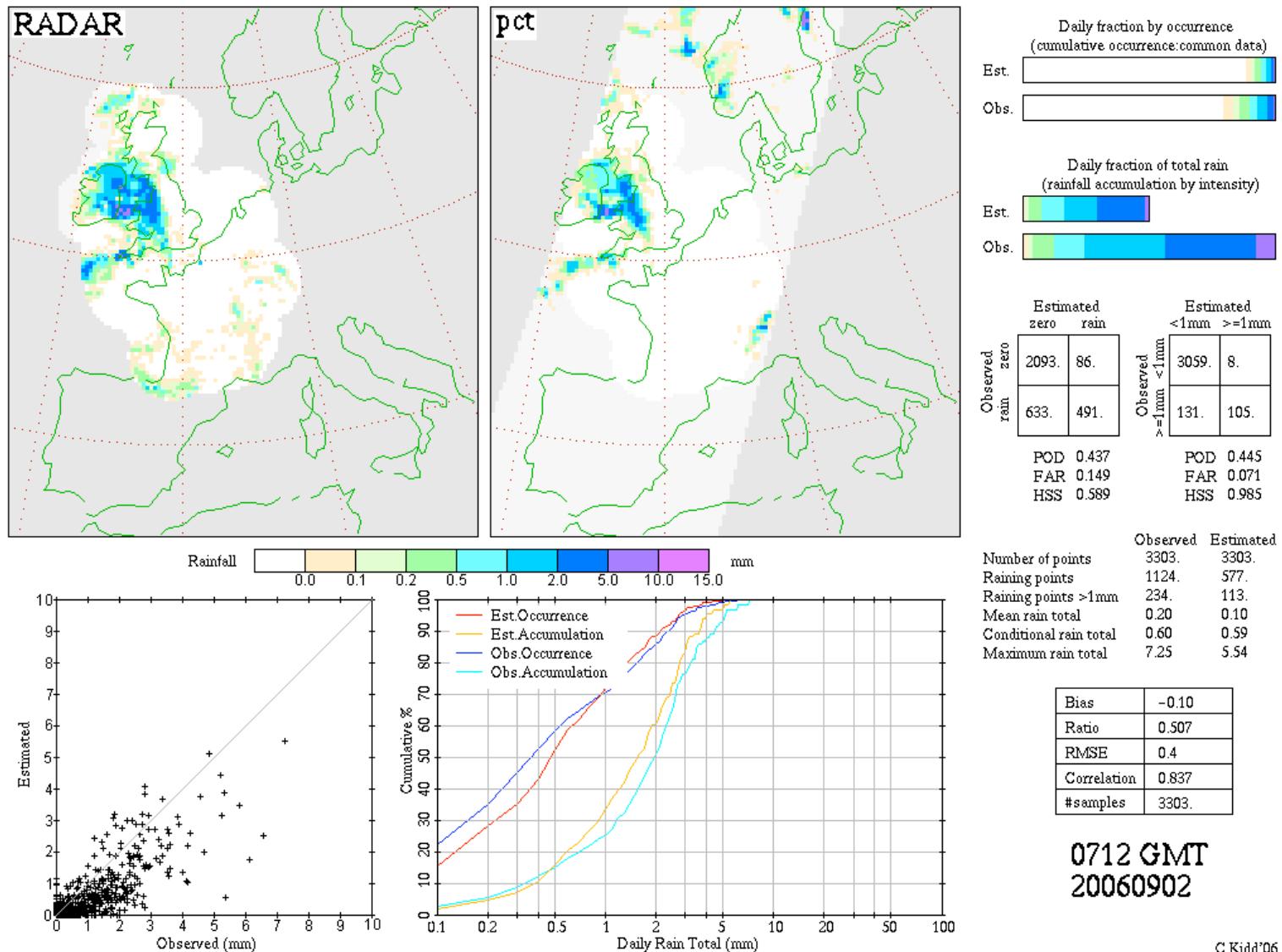


1 minute rain rates derived from Doppler radar

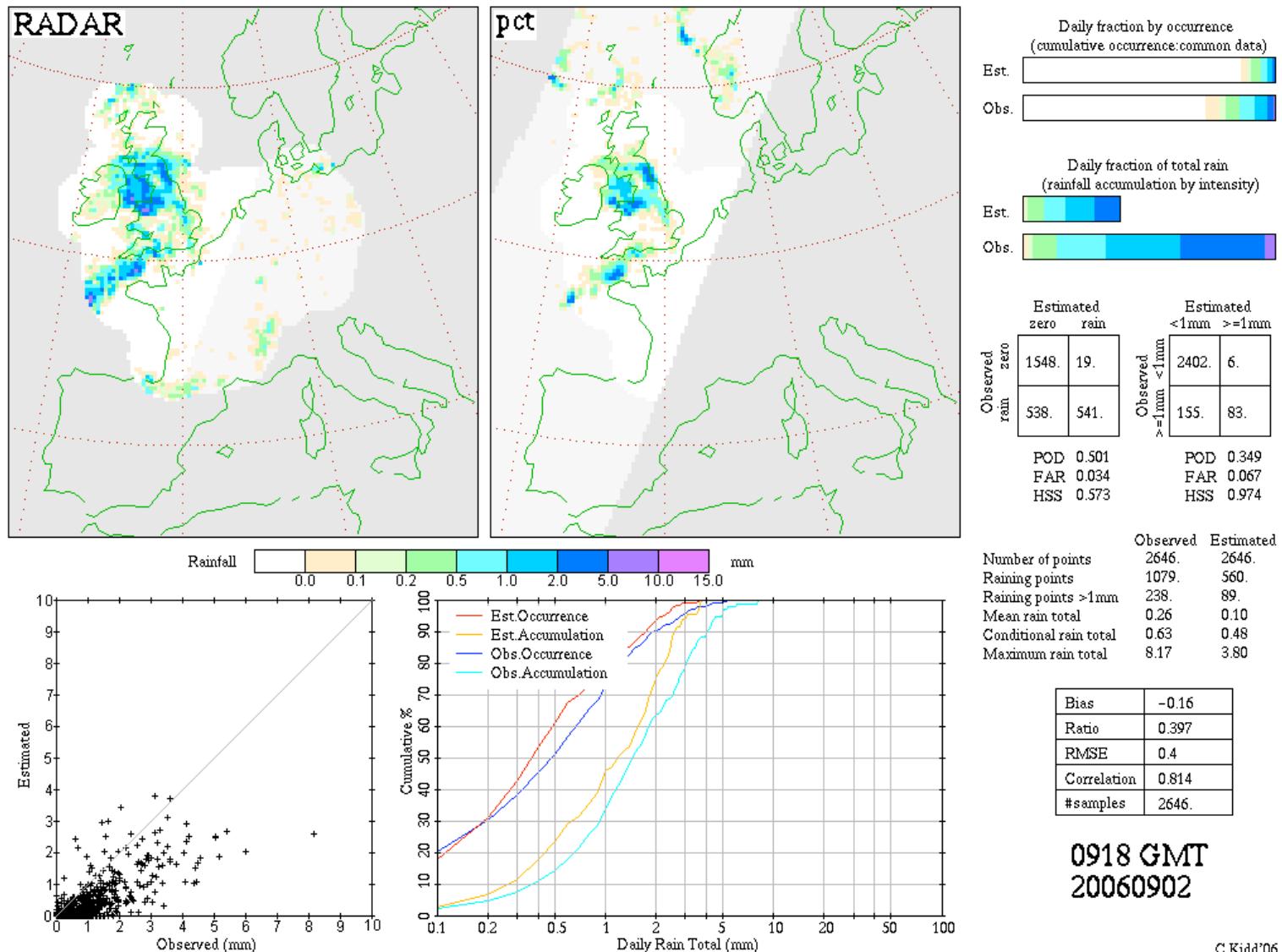
SSMI PCT 06-09-02 06:36



SSMI PCT 06-09-02 07:12



SSMI PCT 06-09-02 09:18



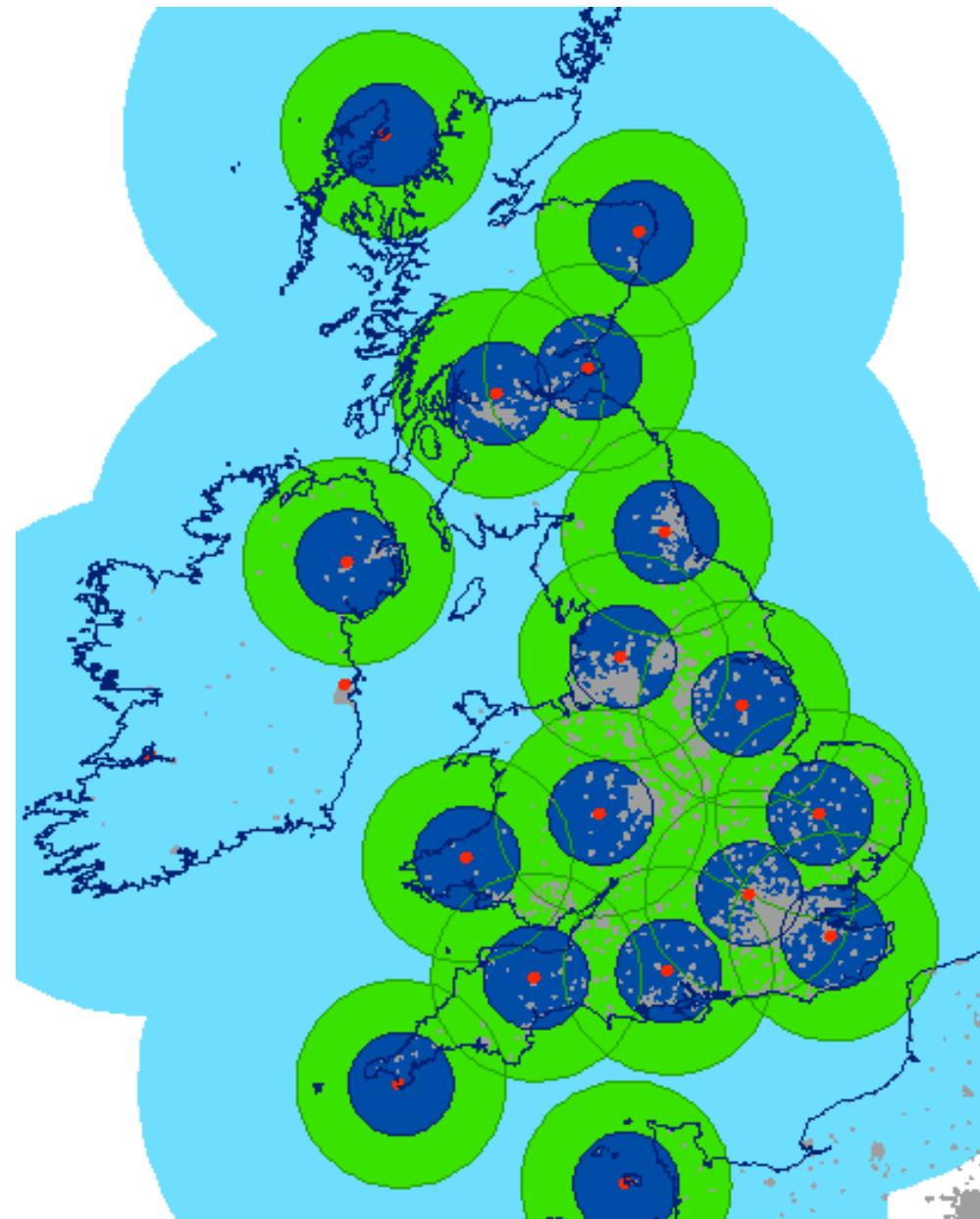
The UK Weather Radar Network

- Met.Office operating authority with network partners
- 14 C-band radars
- Radar spacing ~ 150km in England and Wales
- Thurnham dual-polarization radar - August 2006
- Anglian Water PLC: new radar in E Anglia during 2007
- Northumbrian Water PLC: new radar in the northeast
- 5 Doppler radars in the network (Oct 2006) – 9 by 2007
- Part of wider European radar network



Planned Network Coverage – 2007

- 1km resolution
- 2km
- 5km



Facility for Airborne Atmospheric Measurements (FAAM)

FAAM is a collaboration between the Natural Environment Research Council (NERC), the UK Met Office and the University Community.

Aircraft Characteristics

Crew	Two Pilots
Scientists	18 max
Max Altitude	35,000 ft
Min Altitude	50 ft
Range	3,700 km
Typical Endurance	5 Hours
Min Manoeuvring Speed	90 – 115 m s ⁻¹
Payload	4,000 kg instrumentation



Instrumentation - Current

- radiation instrumentation (Vis, IR, MW)
- in-situ cloud microphysics 0.1 _m to 10 mm
- Various temperature, pressure, humidity and liquid/ice water sensors
- GPS/INU position
- Turbulence/wind velocity
- Dropsondes

Instrumentation - Future

- Differential absorption Lidar (Ozone and water vapour) (2007)
- 94 GHz Cloud radar (Not yet funded)
- Sub-mm radiometer (Not yet funded)

Further Information

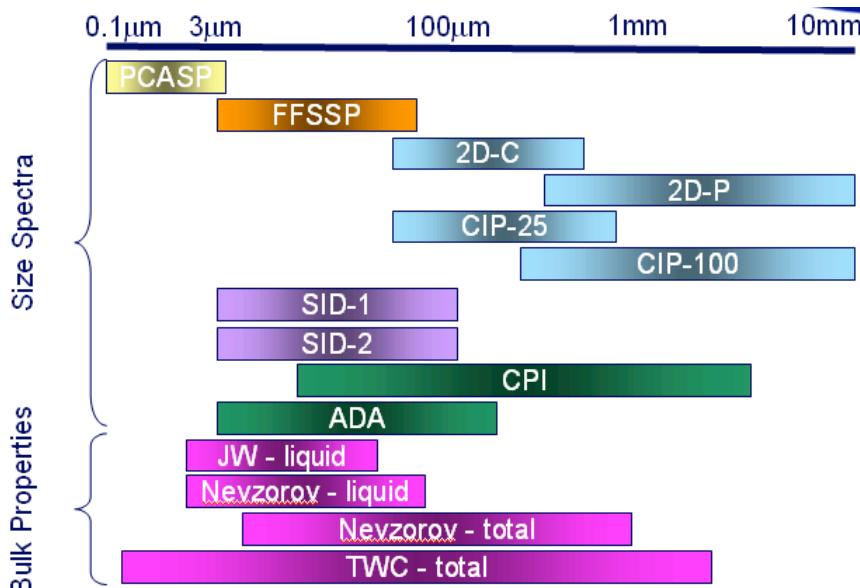
Web: <http://www.faam.ac.uk>



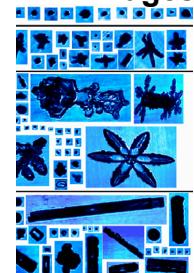
Microwave Radiometers

Instrument	Deimos			MARSS				
	1	3	16	17	18	19	20	
AMSU Channel								
Frequency (GHz)	24	50	89	157	183±1	183±3	183±7	
View angles along track	Up or Down +35° to -5°			Up and Down +40° to -40°				
Beamwidth (FWHM)	11°	11°	12°	11°	6°	6°	6°	
Sensitivity NEΔT (K)	0.6	0.6	0.5	0.7	0.6	0.4	0.3	
Cal Acc. (K)	3	3	0.9	1.1	1.0	0.9	0.8	

Cloud Physics Probes



CPI Images



2DP/2DC Images



FAAM campaigns relevant to GPM

MICROMIX

- Investigation of mixed phase and precipitating cloud events over UK on an ad hoc basis
- In conjunction with Chilbolton radar facility and/or satellite overpasses
- 5 flights to date, 2 or 3 more available

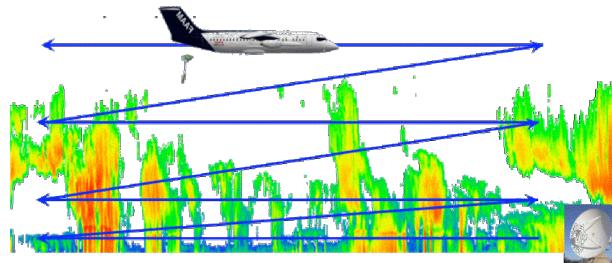
IASI Cal/Val

- UK and detachment based flying planned
- Scope for investigations when IASI Cal/Val not possible, AMSU and MHS on METOP.
- First half 2007

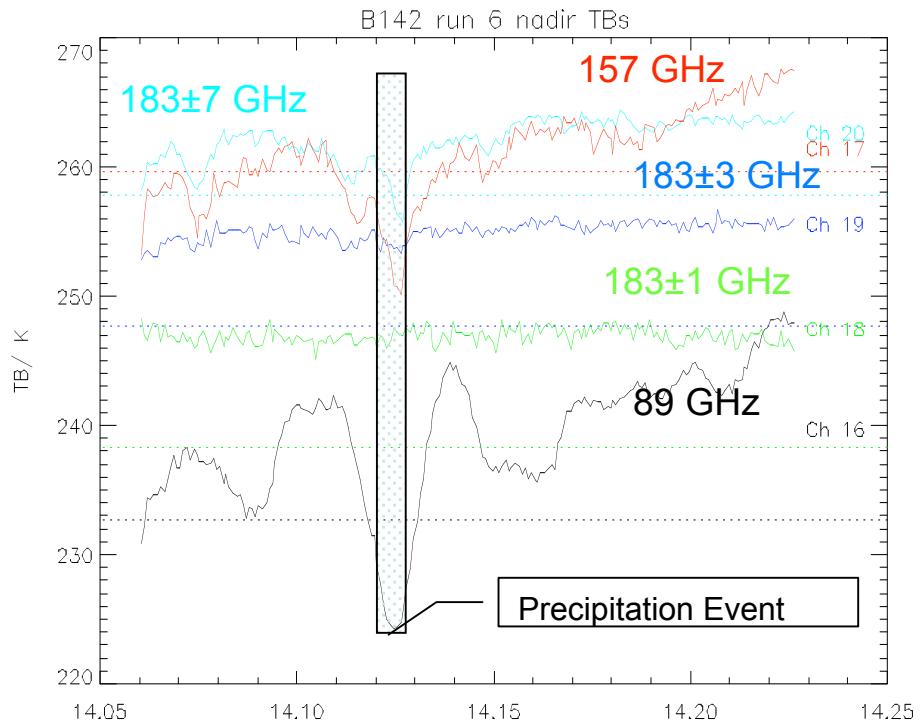
Rainclouds

- Some flying planned in support of failed EU FP6 Rainclouds bid.
- Some flying hours still available for this activity
- Possibility for coordinated flying with other aircraft
- Late 2007

MICROMIX type flight with Chilbolton Radar



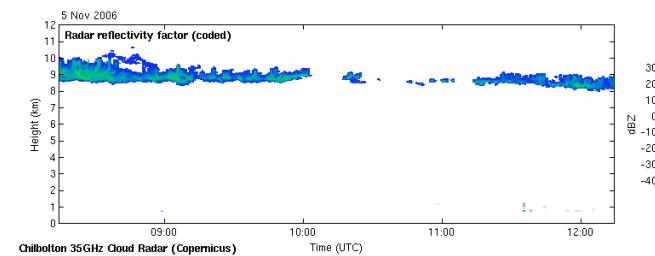
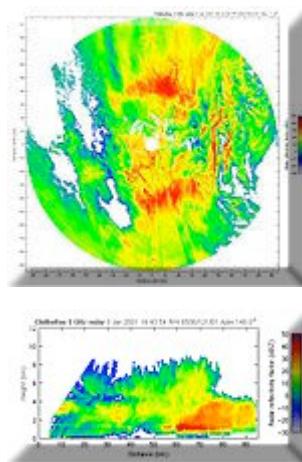
Stratiform cloud with embedded precipitation
29 kft Nadir MW BTs



Advanced Weather Radar

Chilbolton Facility for Atmospheric and Radio Research at Chilbolton in Hampshire.

- 3 GHz Doppler-Polarisation radar: 25 metre fully steerable antenna, and the 1275MHz clear air radar.
- A 94GHz and 35GHz cloud radar are located alongside the main dish: for studying cloud, ice and rain
- supported by a suite of meteorological instruments, cameras and lidars on the same site



Daily vs hourly gauge data

Daily gauge network

06-06Z



Hourly gauge network

(Near real-time)

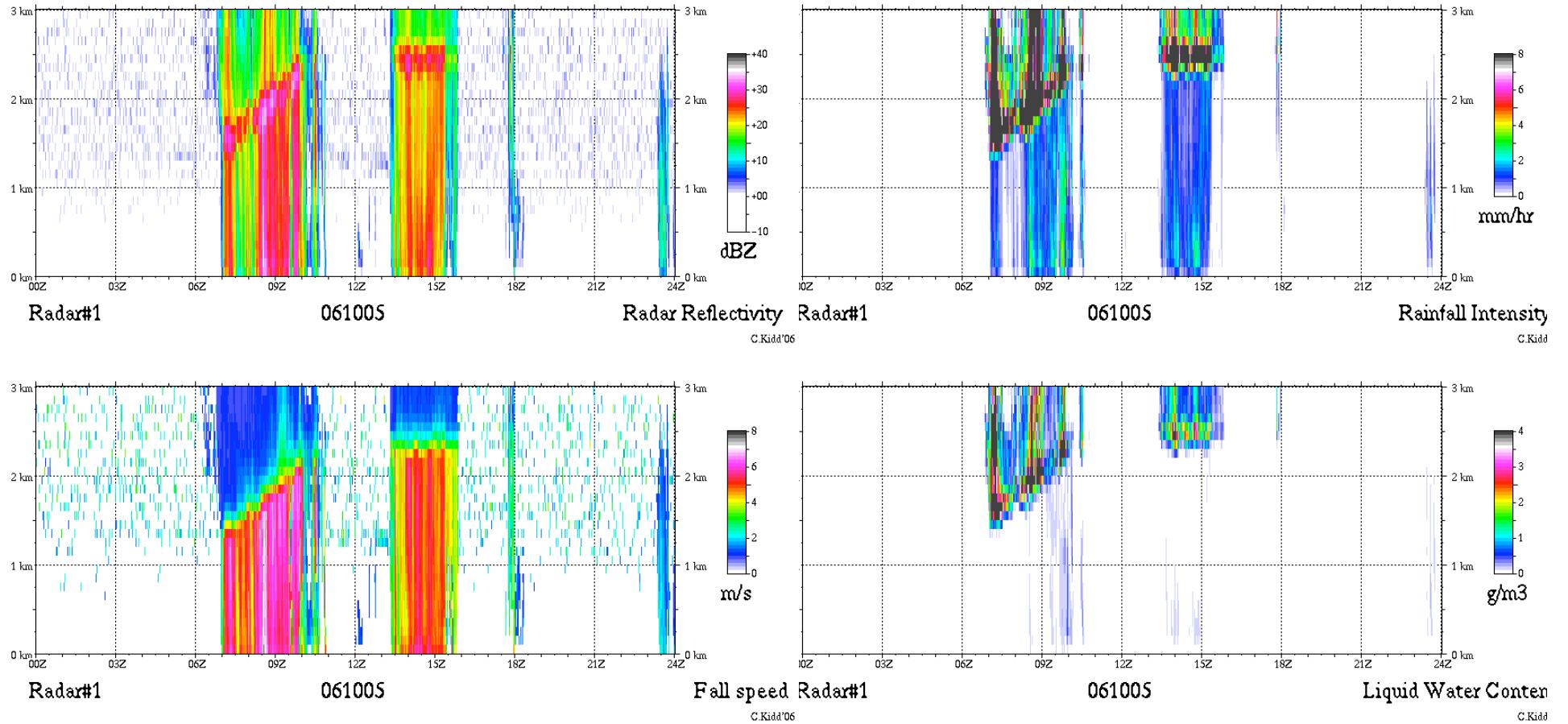


Birmingham facility

- 4 micro rain radars – vertical Doppler, 24.1 GHz
- 8 calibration gauges (2 per radar)
- 16 outer gauges
- zeus lightning network
- rain sampler (0.2 mm/tip –
DOC & isotopic analysis)

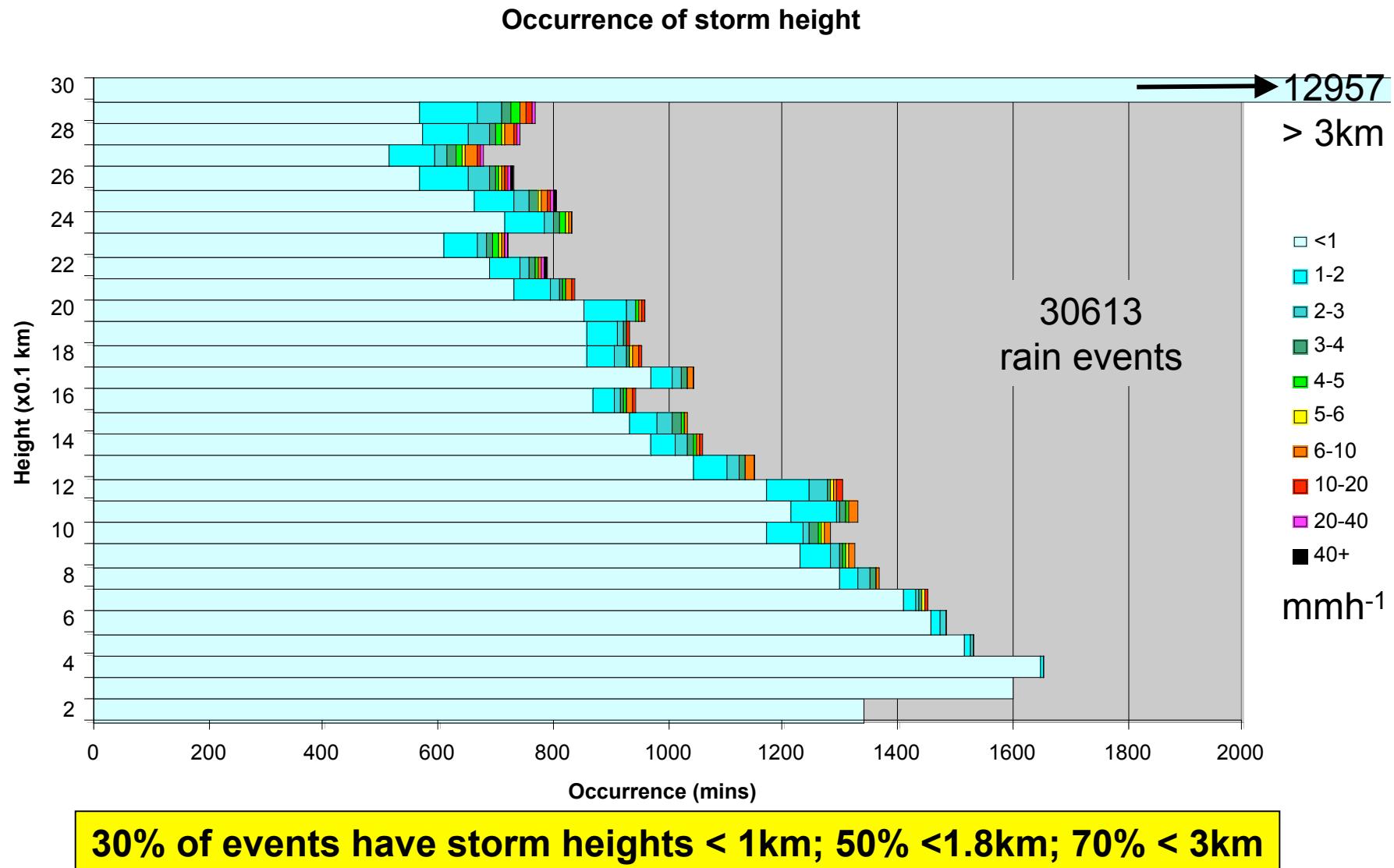


Vertical Doppler radar plots

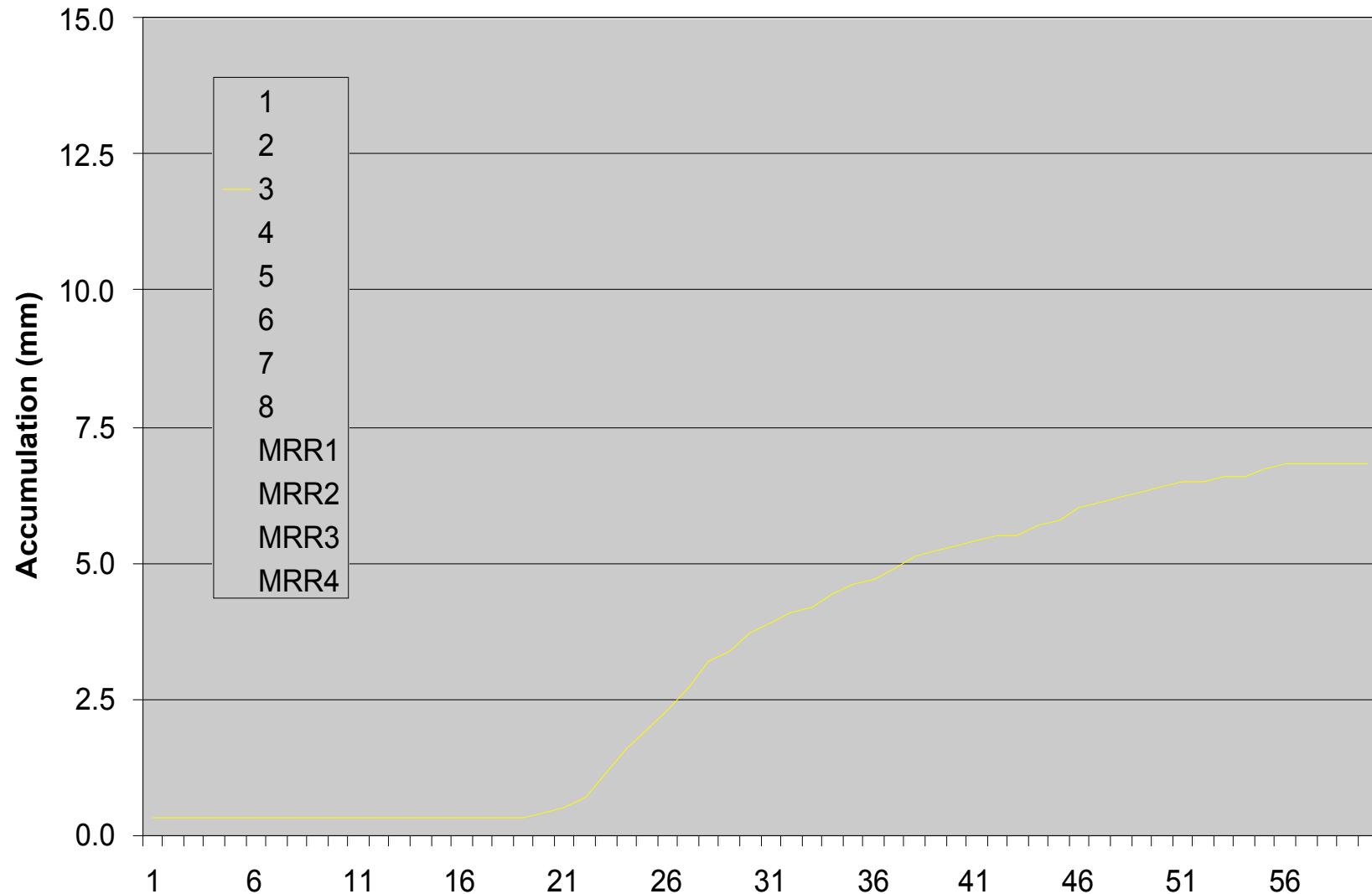


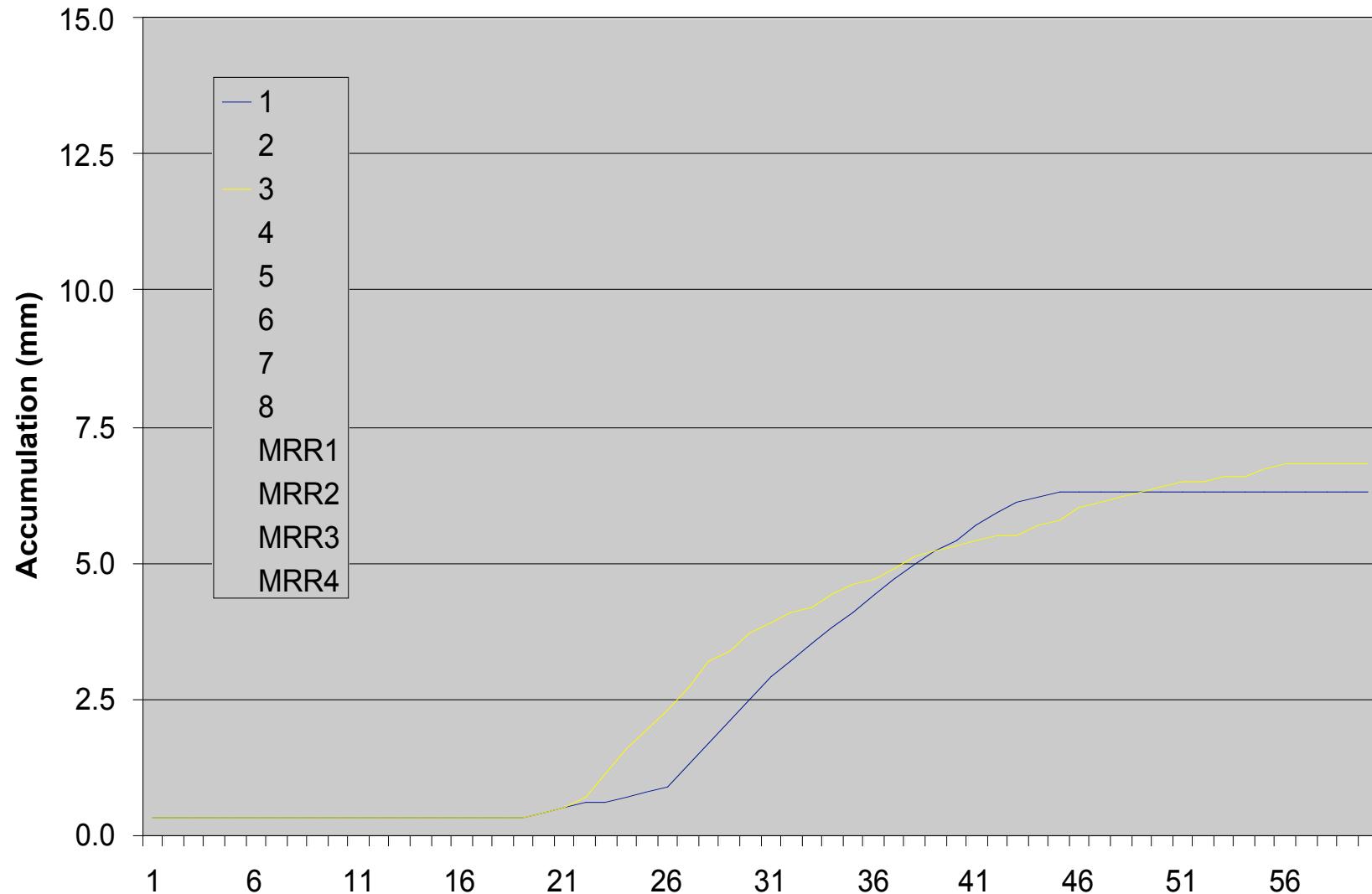
5th October 2006: Warm front

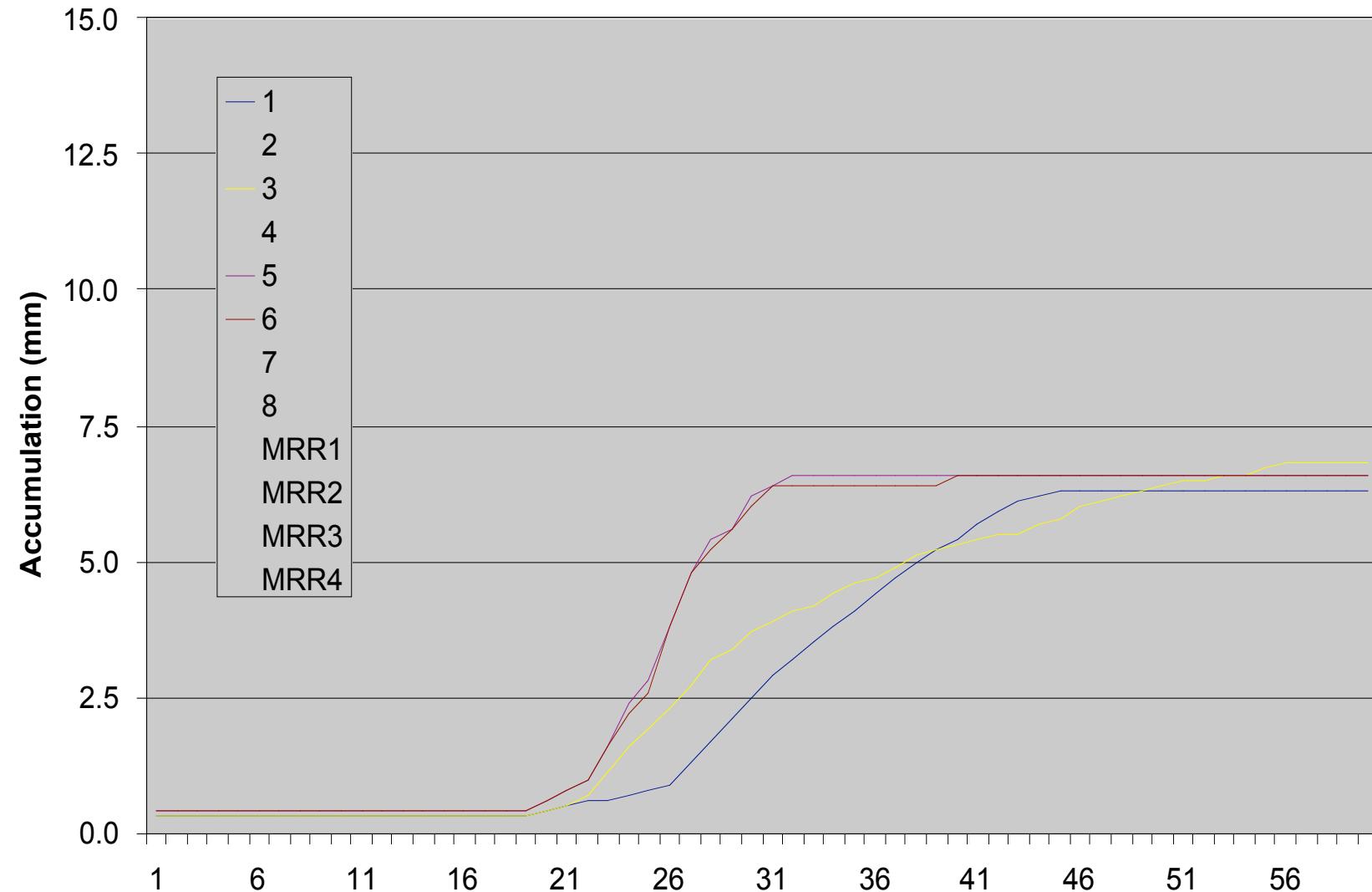
MRR derived storm height

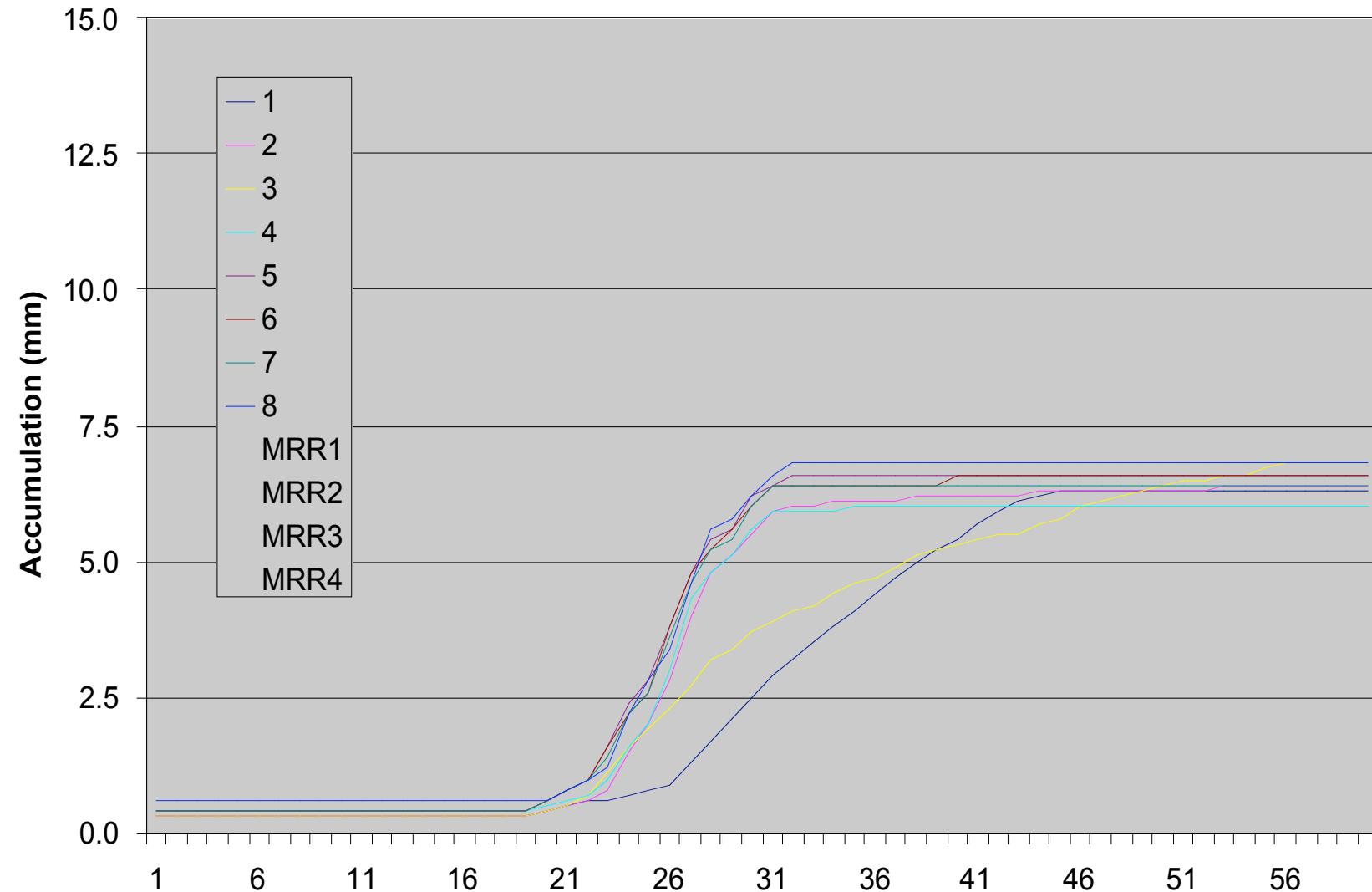


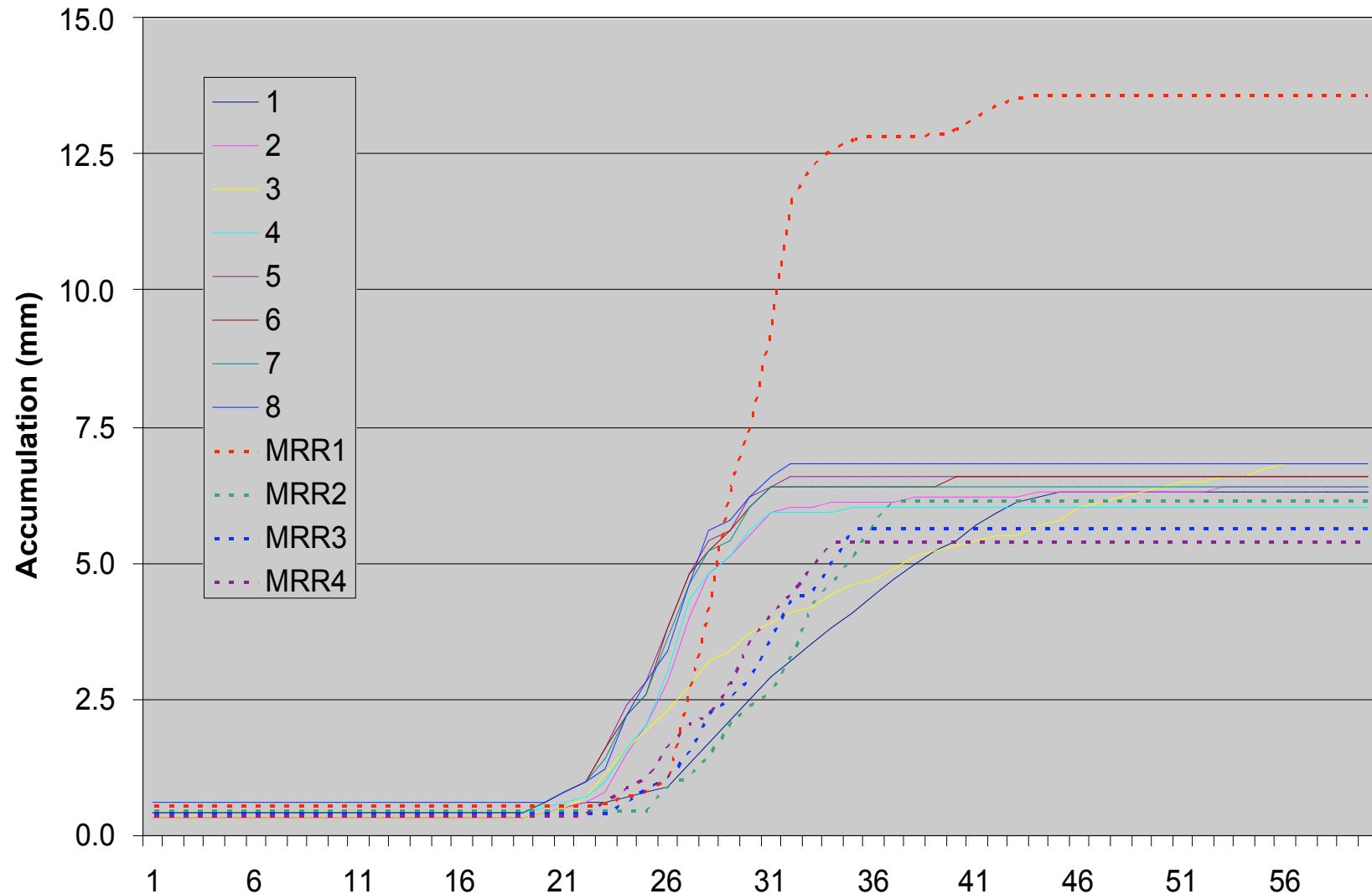
Truth? 8 Gauge / 4 MRR comparison











Human resources

RAINMAP

- Group of UK researchers, funded by the Engineering and Physical Sciences Research Council (EPSRC)
- Primarily looking at modelling rain fade in MW signals
- Wider applications include downscaling for erosion and hydrological purposes (e.g. urban flooding)

EO groups

- Birmingham/UCL/Sussex/Hull – PM/IR retrievals/applications
- Reading – Vis/IR estimates

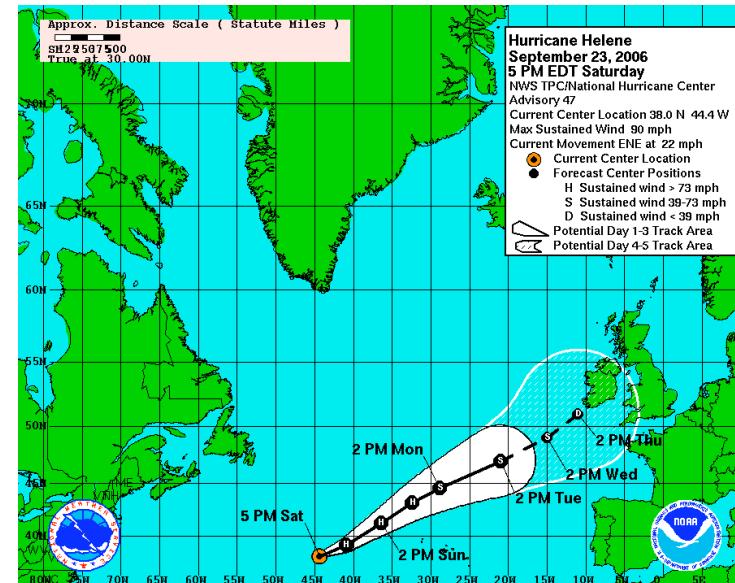
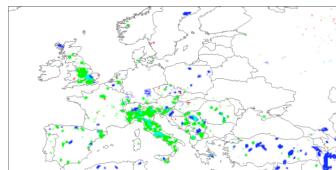
Modelling/microphysics groups

- Leeds – modelling work
- Met Office

Participation within European activities (e.g. RAINCLOUDS-light)

Conclusions

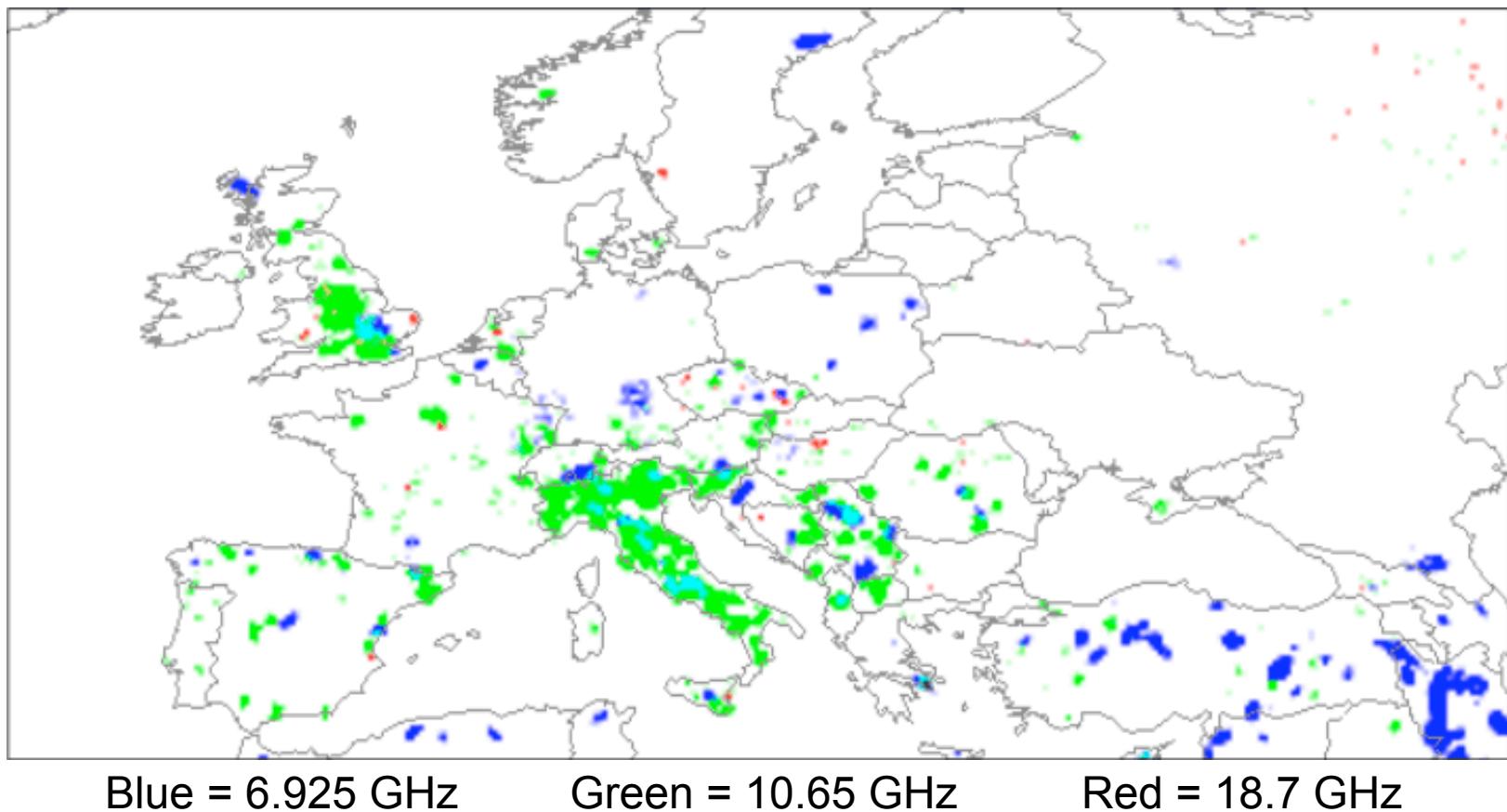
- Light rainfall is very important:
 - particularly for maritime regions, mid- to high-latitudes
 - 85%occ & 25%acc < 1mmh⁻¹
- Excellent GV equipment:
 - radar (national, advanced weather radar and local),
 - gauges (daily & hourly)
 - aircraft
- Personnel:
 - GV & EO expertise



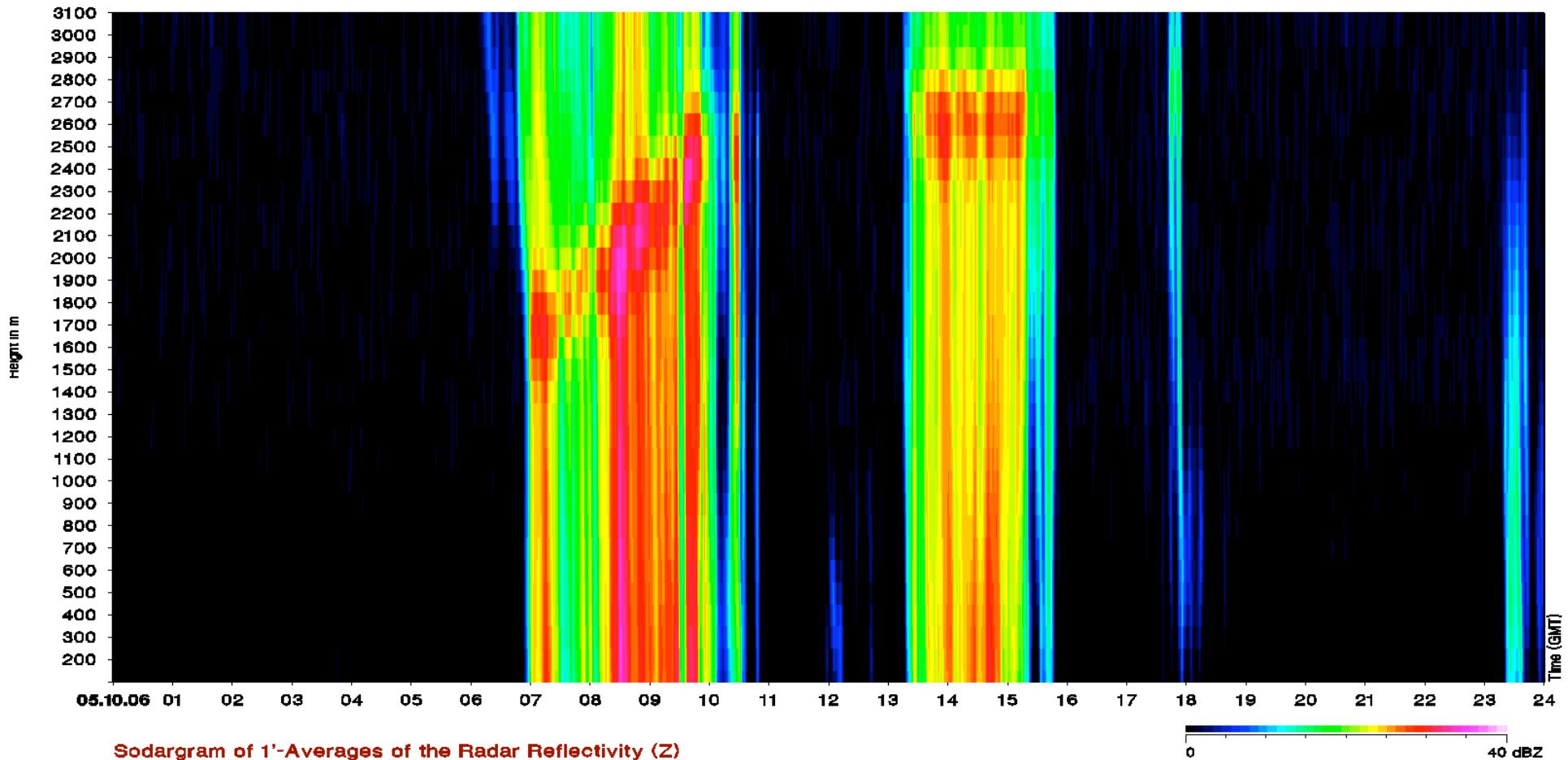
Equipment infrastructure

- Radar network
- Gauge network
- Aircraft facilities

RFI over Europe



MRR reflectivity



Rain/no-rain induced biases

Problem:

- if a satellite estimate cannot retrieve light rain, it should underestimate rain totals
- corrections are usually made to correct this bias, so that it matches the 'real' rainfall
- this can lead to unintended regional biases
 - Differences in rain/no-rain boundaries reveal regional variations that do not exist in reality
 - Further complicated since rain/no-rain boundaries tend to differ over land/sea areas



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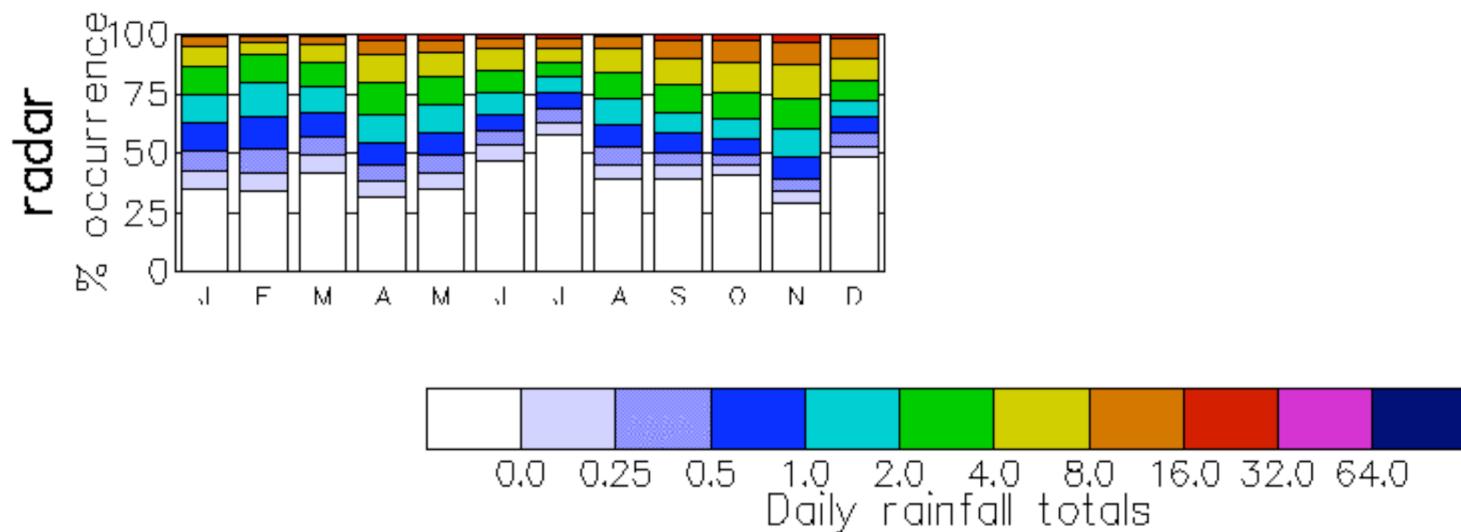
3rd IPWG workshop, Melbourne, Australia. 23-28 October 2006



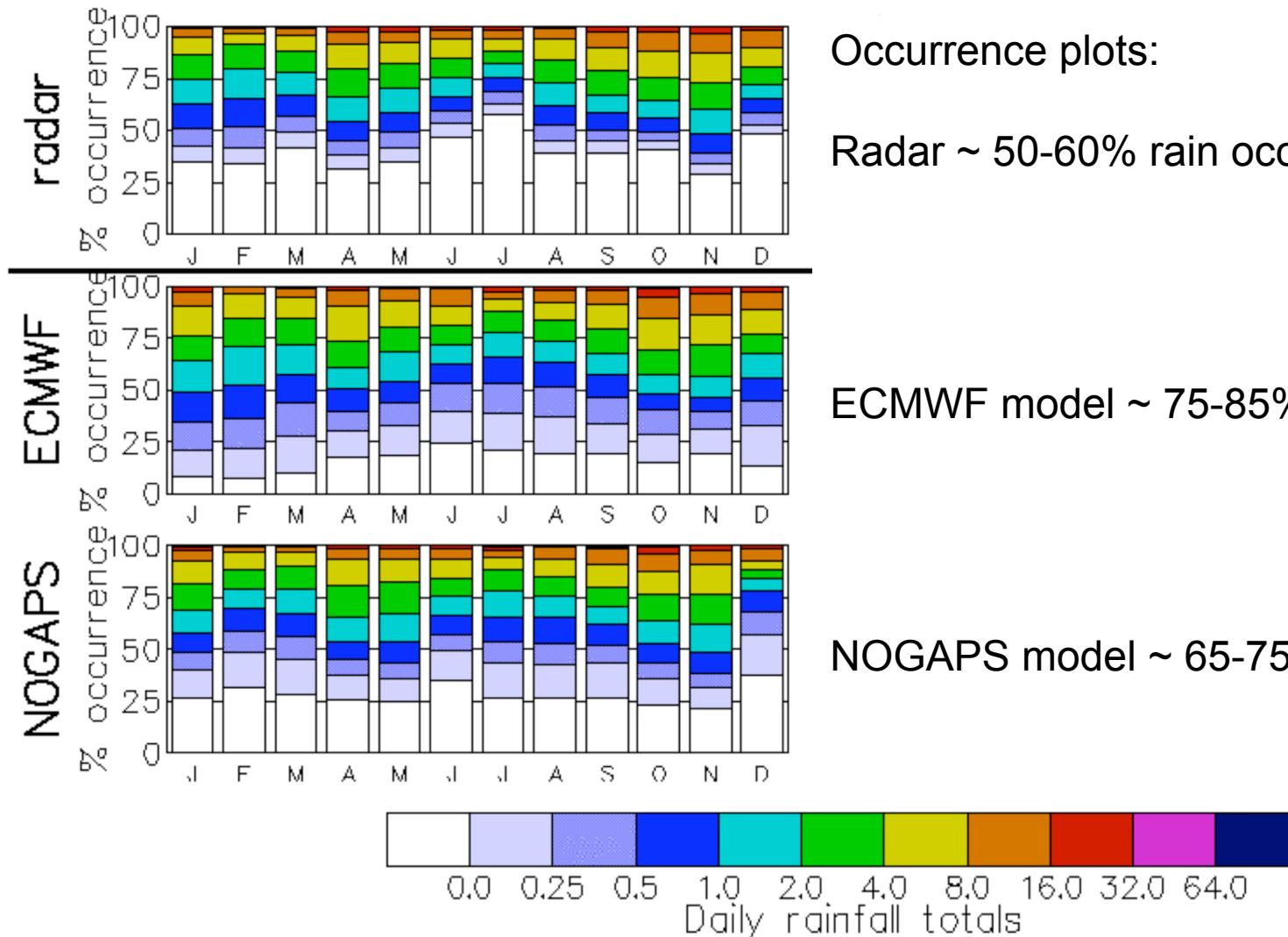
How well are we doing?

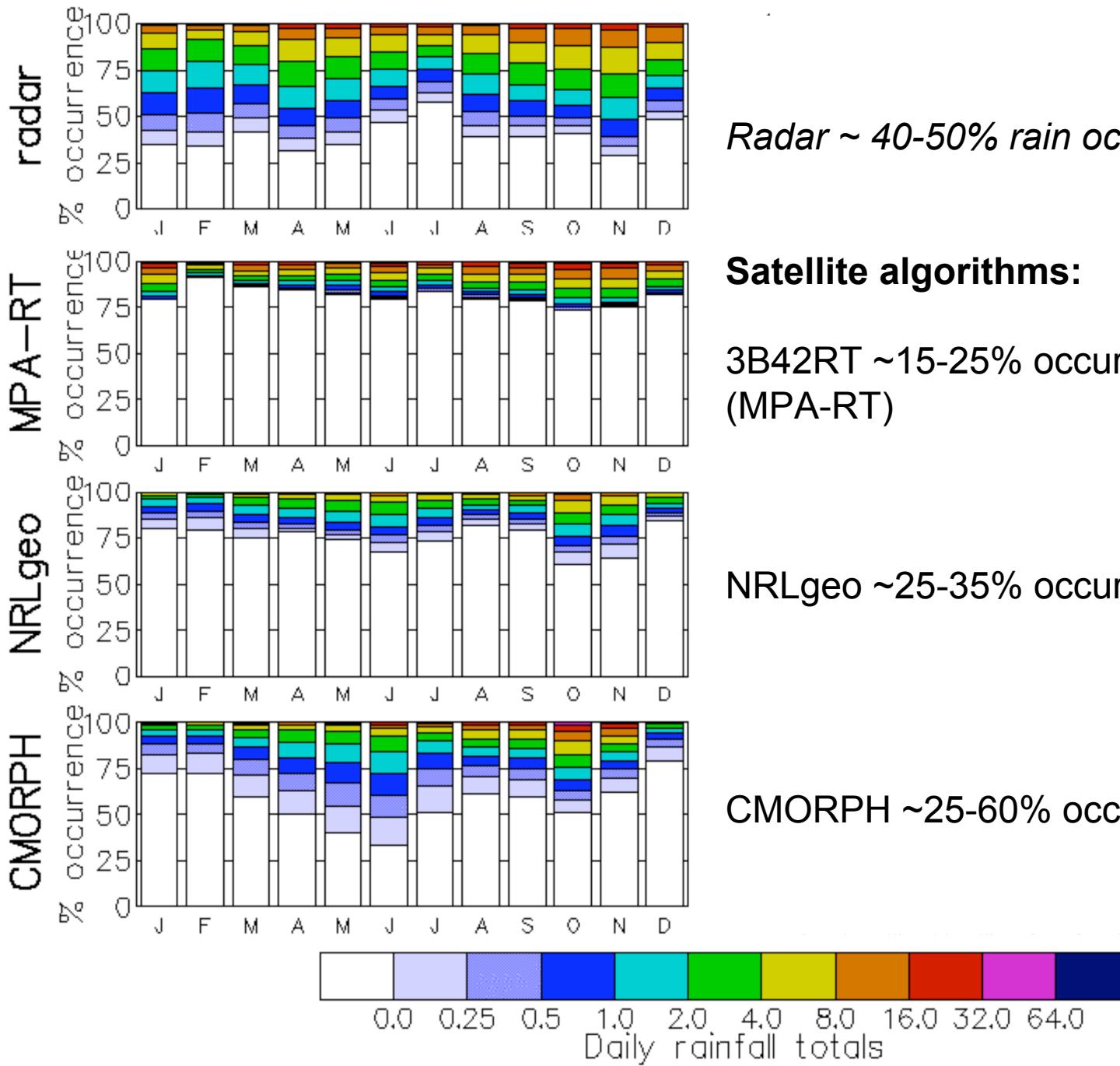
Occurrence of rainfall:

Cumulative percentage of the occurrence of rainfall by daily totals
- significant occurrence < 2 mm/day



Rainfall occurrence and accumulation





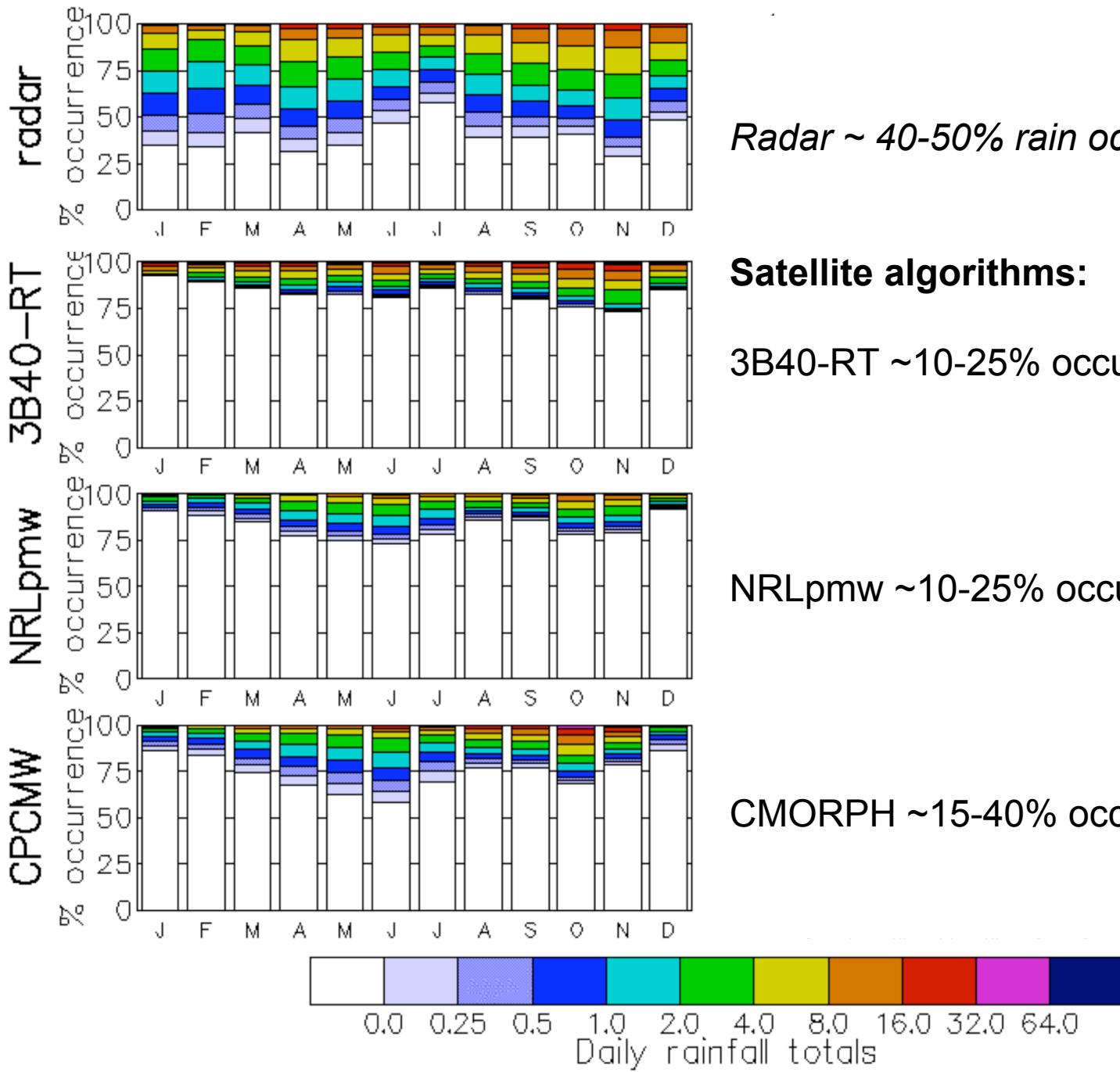
Radar ~ 40-50% rain occurrence

Satellite algorithms:

3B42RT ~15-25% occurrence
(MPA-RT)

NRLgeo ~25-35% occurrence

CMORPH ~25-60% occurrence



Radar ~ 40-50% rain occurrence

Satellite algorithms:

3B40-RT ~10-25% occurrence

NRLpmw ~10-25% occurrence

CMORPH ~15-40% occurrence

Low rainfall identification

How well do algorithms identify light rainfall?

- Difficult to assess since the IPWG products are daily estimates, not instantaneous...

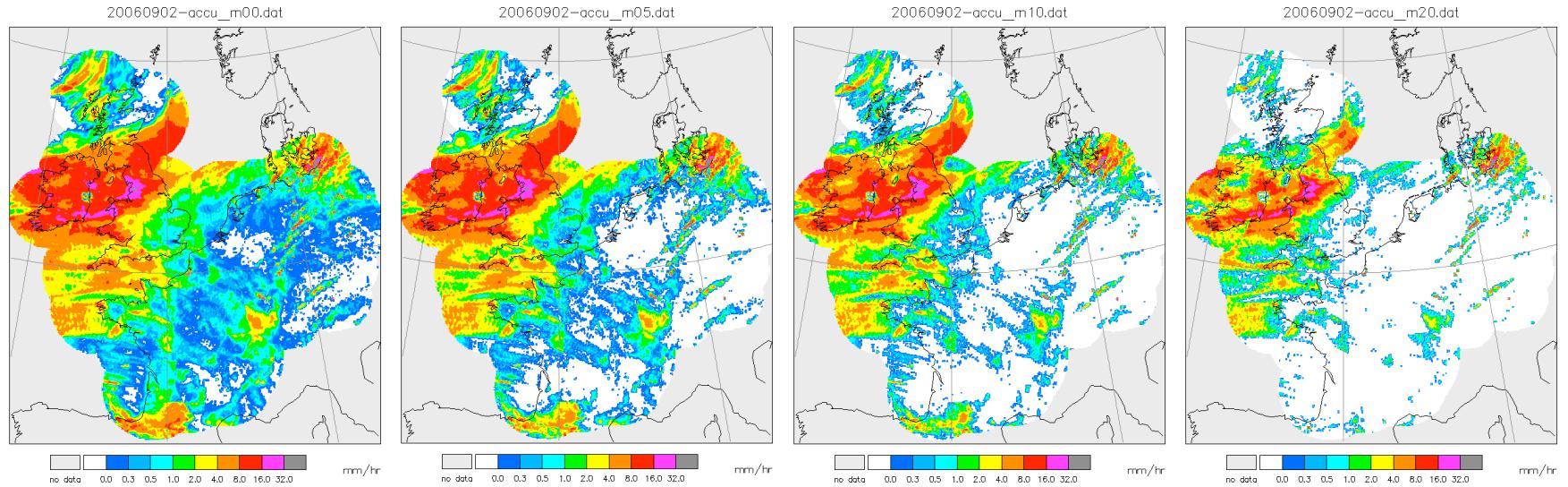
However, the radar data, available every 15 minutes, can be used:

Radar sensitivity to light rain rates is reduced by setting rain rates below a certain threshold to zero – thus matching the algorithms insensitivity.

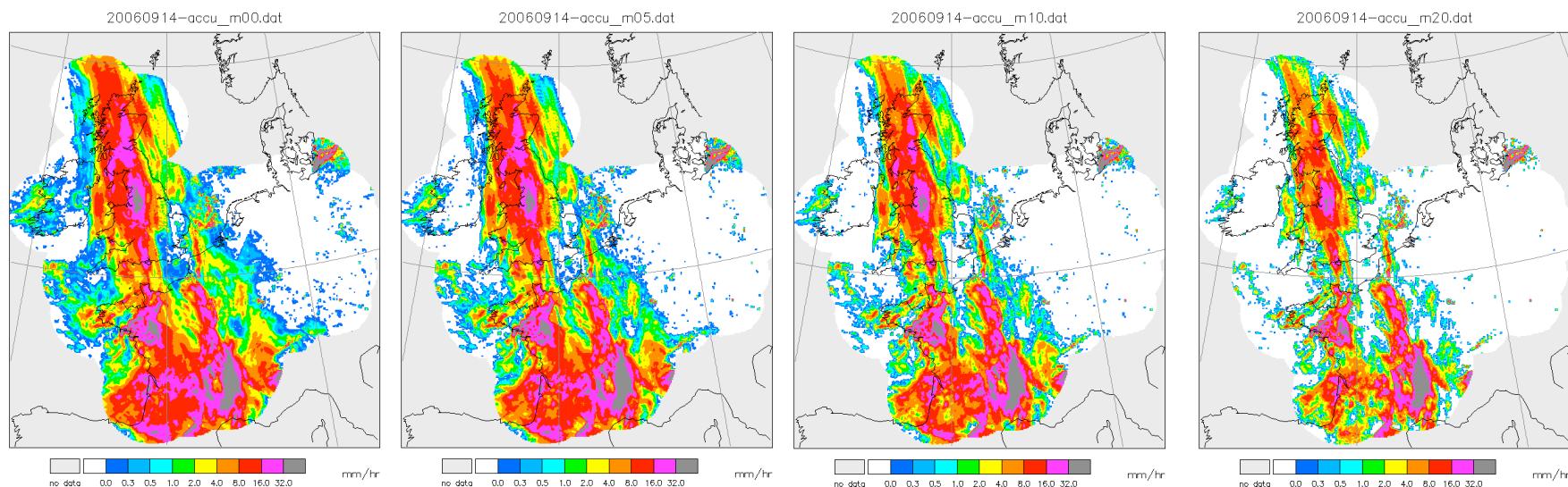


Effect of removing light rain rates

Frontal



Convective



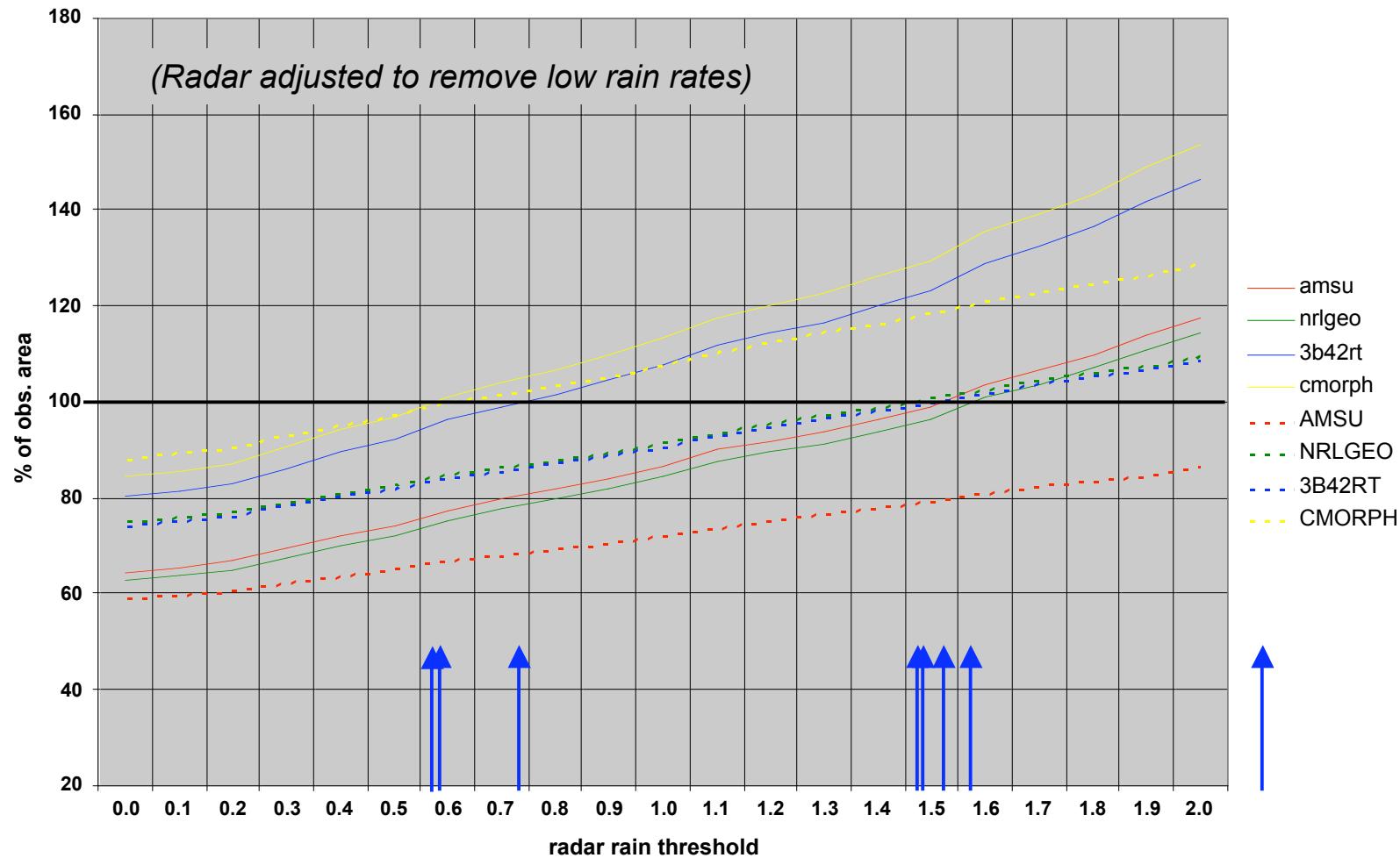
<0.0_0.0

<0.5_0.0

<1.0_0.0

<2.0_0.0

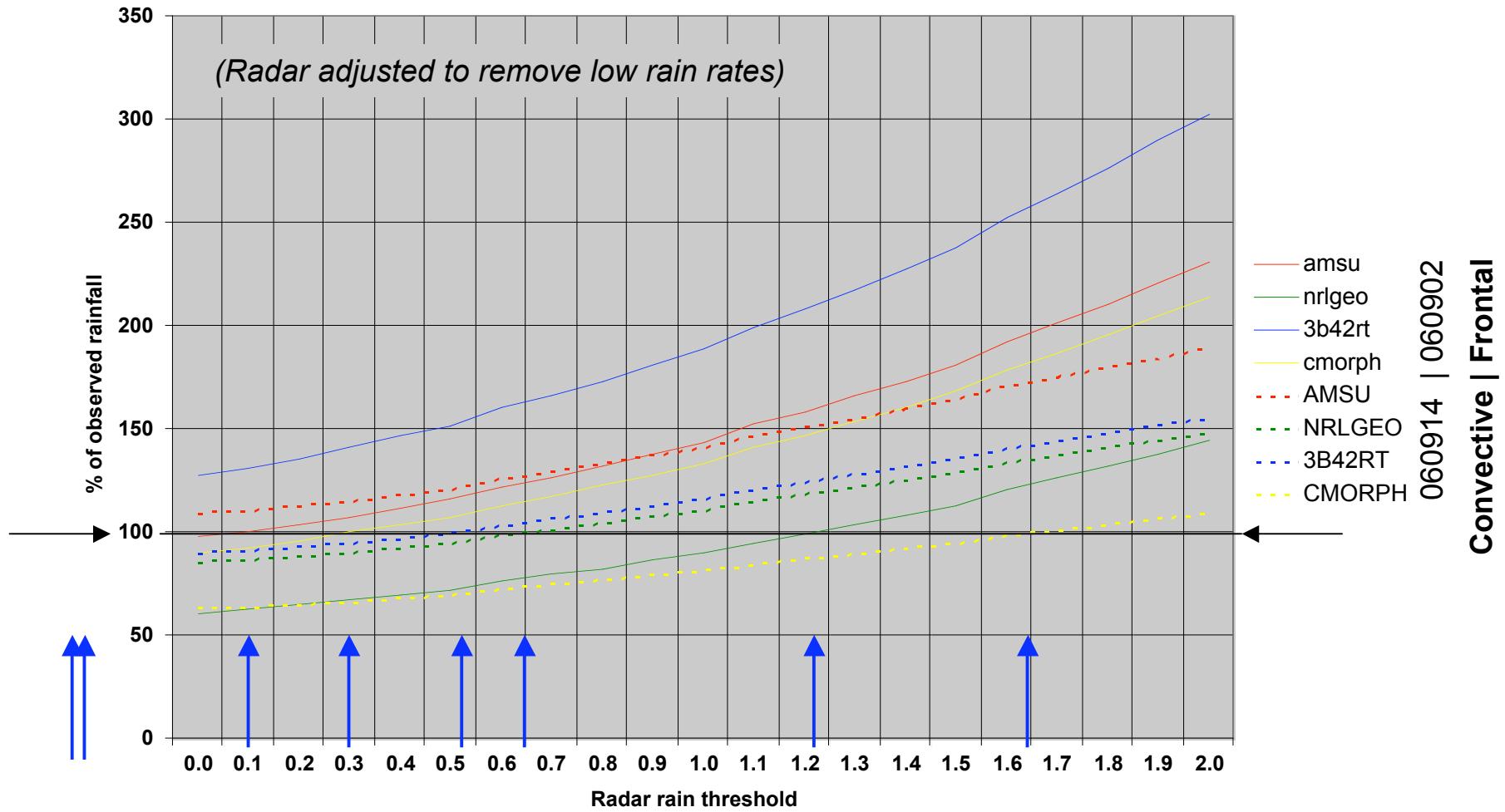
Rain area



In terms of rain area: algorithms underestimate the area, e.g. CMORPH has a threshold of about 0.5 mm/hr; AMSU ~1.5 mm/hr for stratiform and > 2 mm/hr for convective.



Rain totals ratio



In terms of rain amount the problem is less acute: some over-estimate rain amounts (while underestimating the rain areas); NRLgeo has a threshold ~1.2 and 0.6 mm/hr.



Algorithm performance

Algorithms:

- generally underestimate the rain area (0.6-0.9)
- are equally split on rain amount (0.6-1.4)

Consequently algorithms overestimate the conditional rainfall

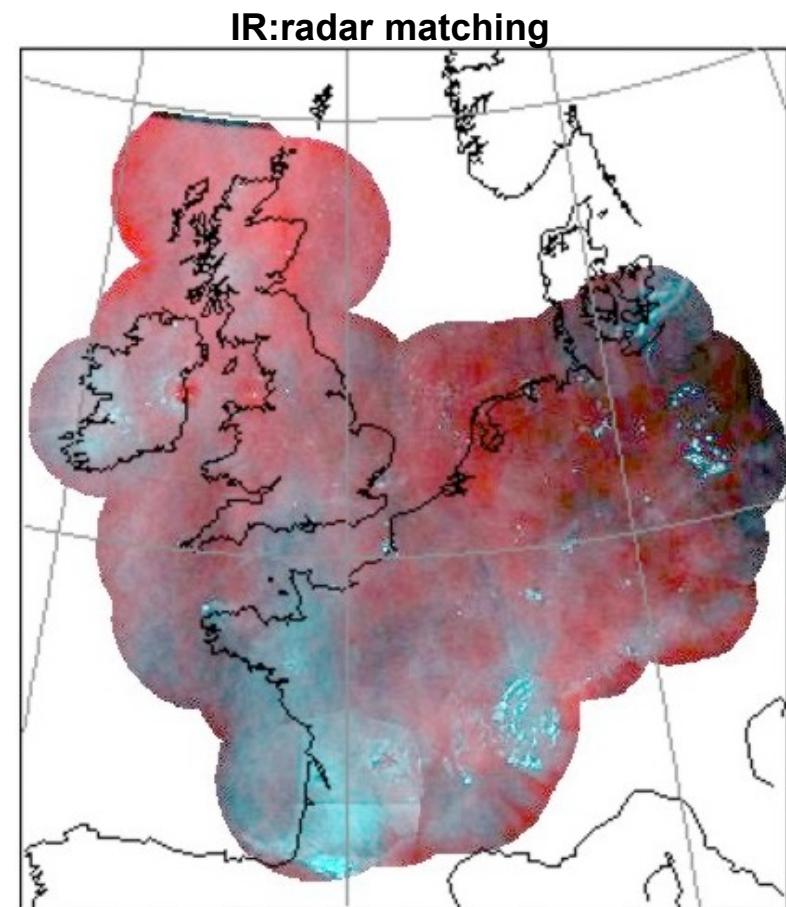
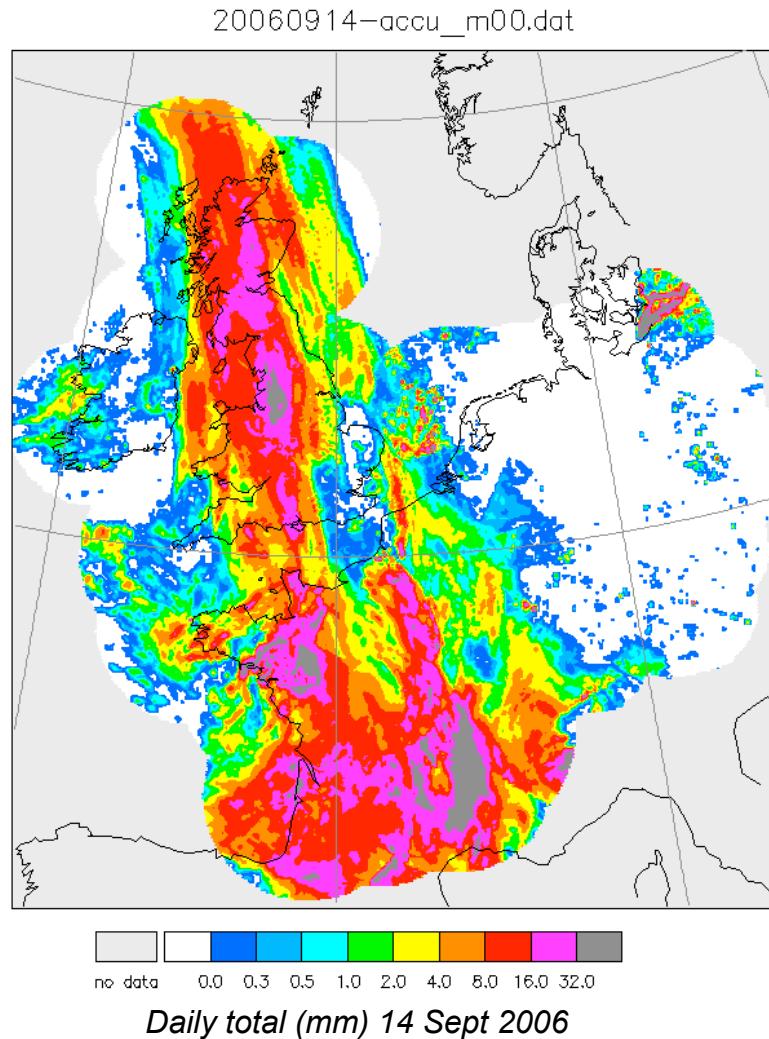
In addition, different rain situations create different problems:

CMORPH ~ same for rain area for both *frontal* and *convective* rainfall,
but very different for total rainfall

AMSU which gets the rain totals about right, fails to get the rain areas right.



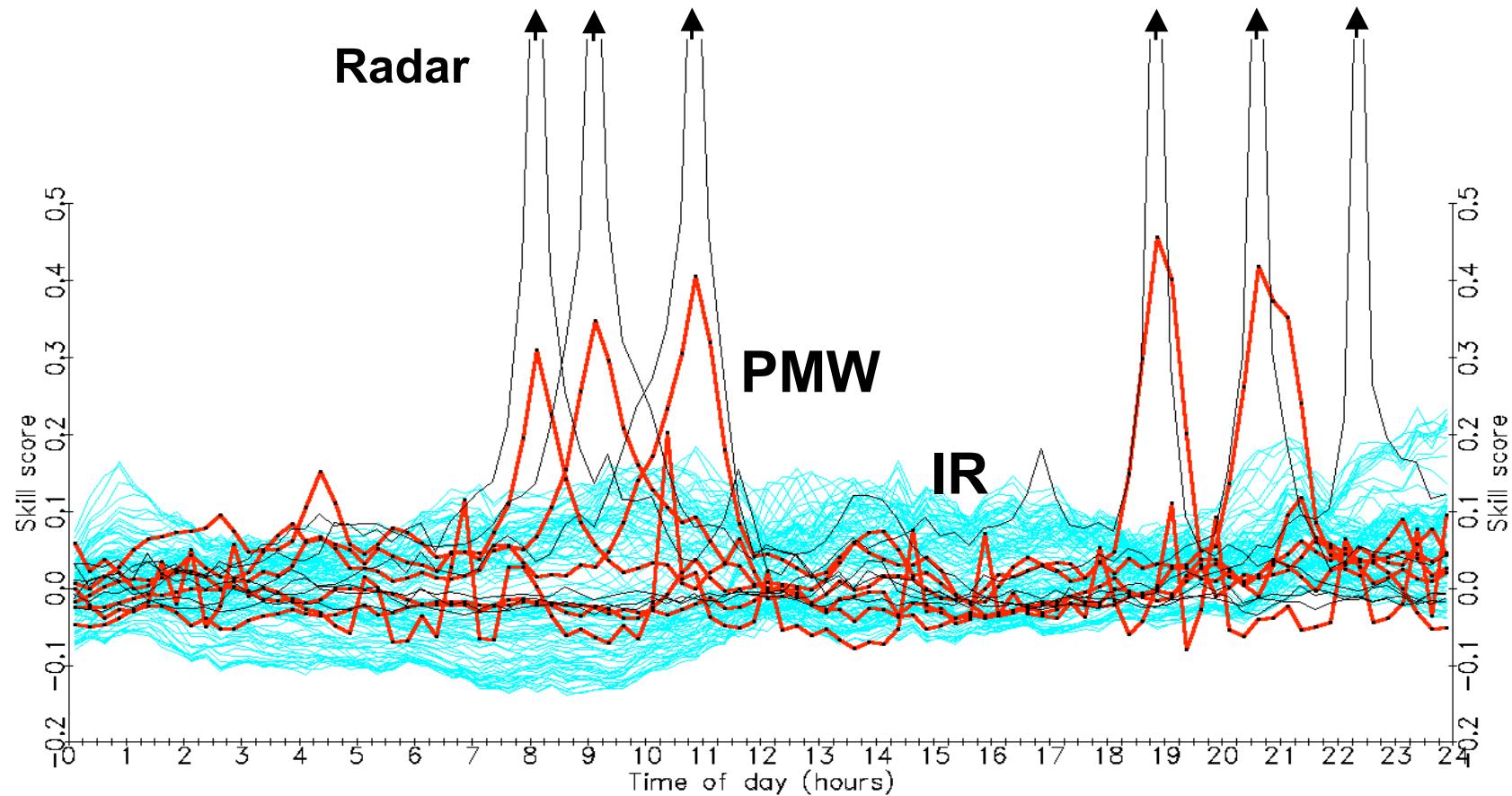
Radar: advantages/disadvantages



Blue = radar rain / IR no-rain
Red = IR rain / radar no-rain



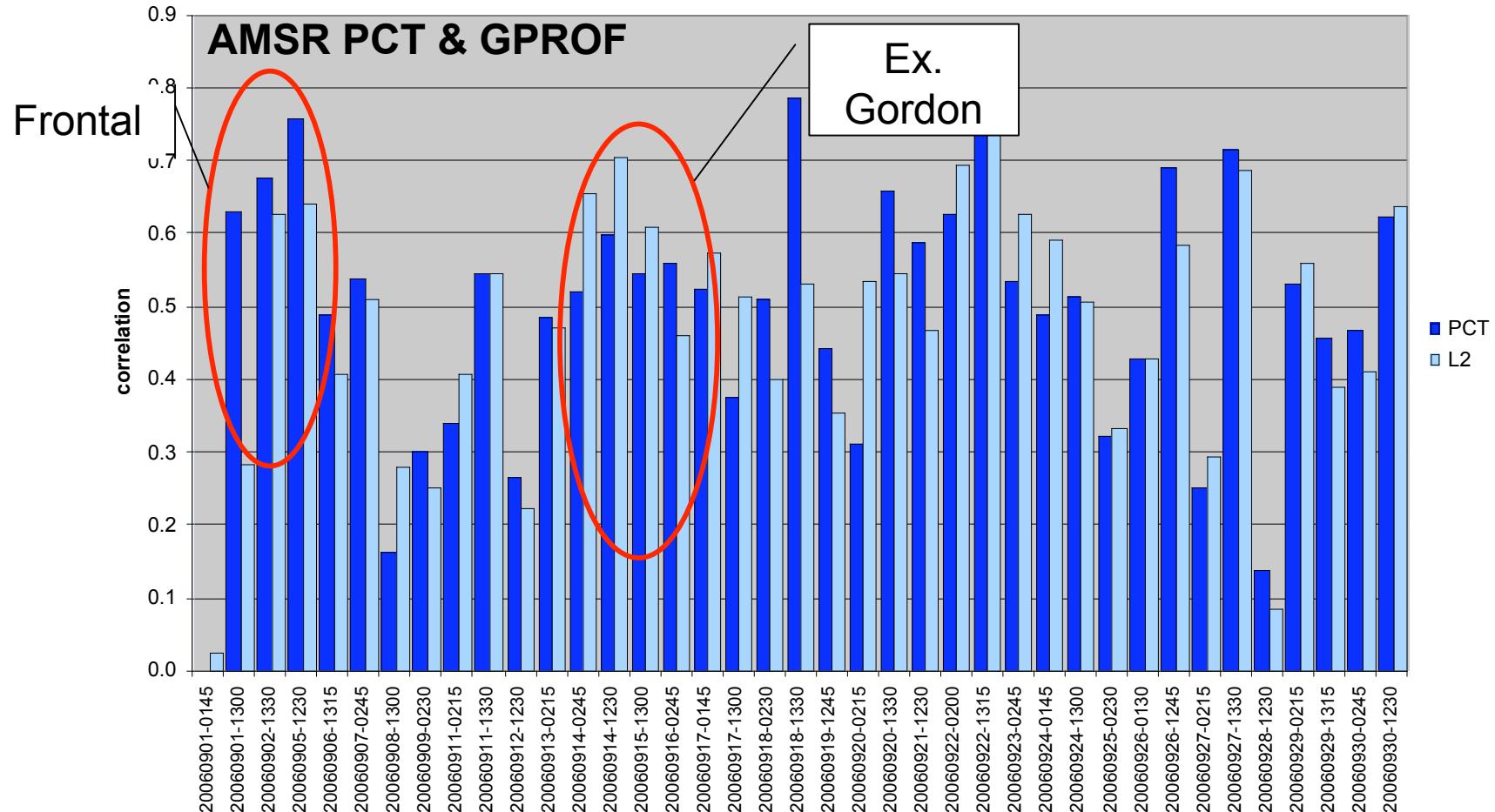
Time skill scores of rain retrievals



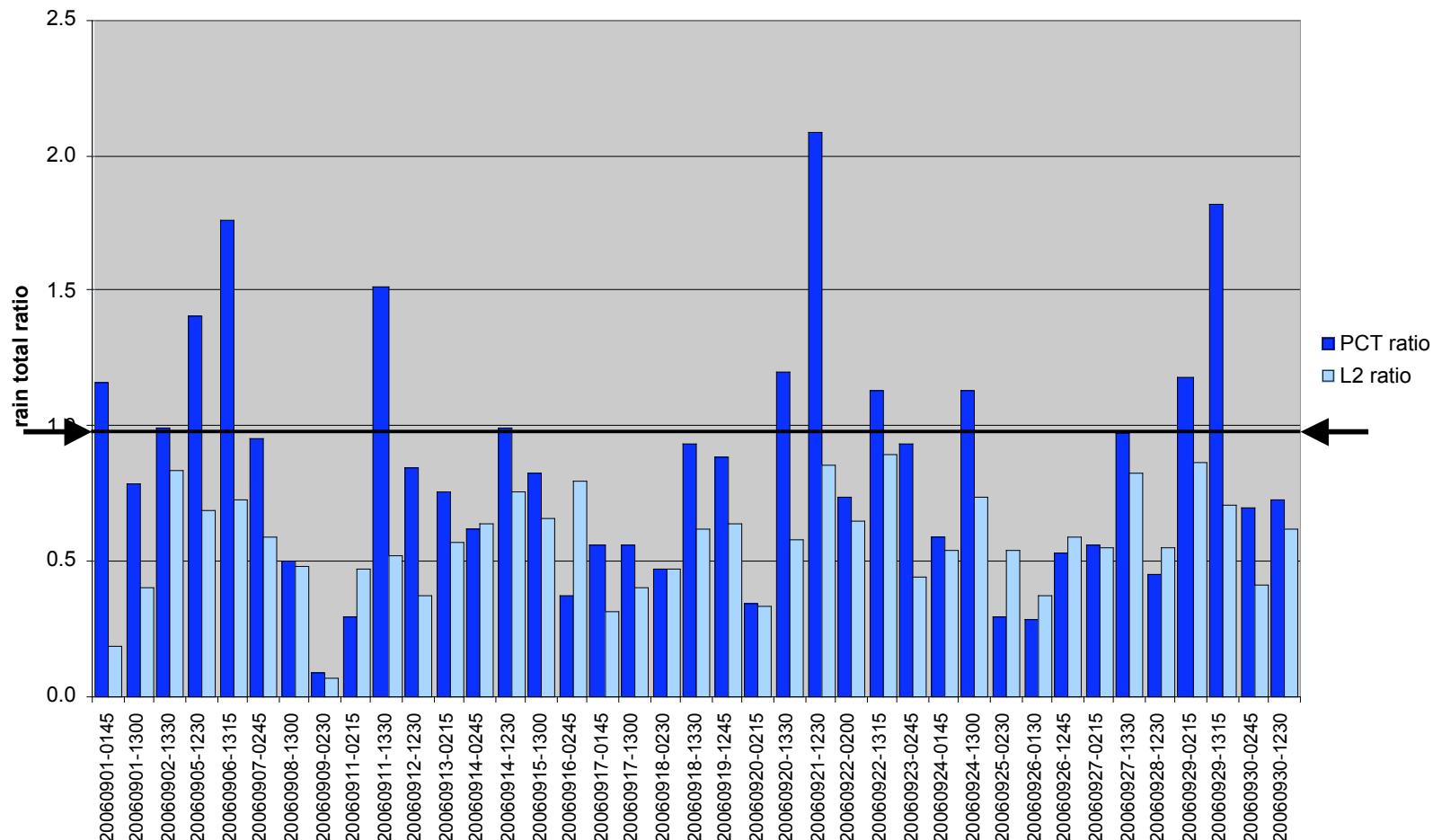
Rainfall is temporally very fickle



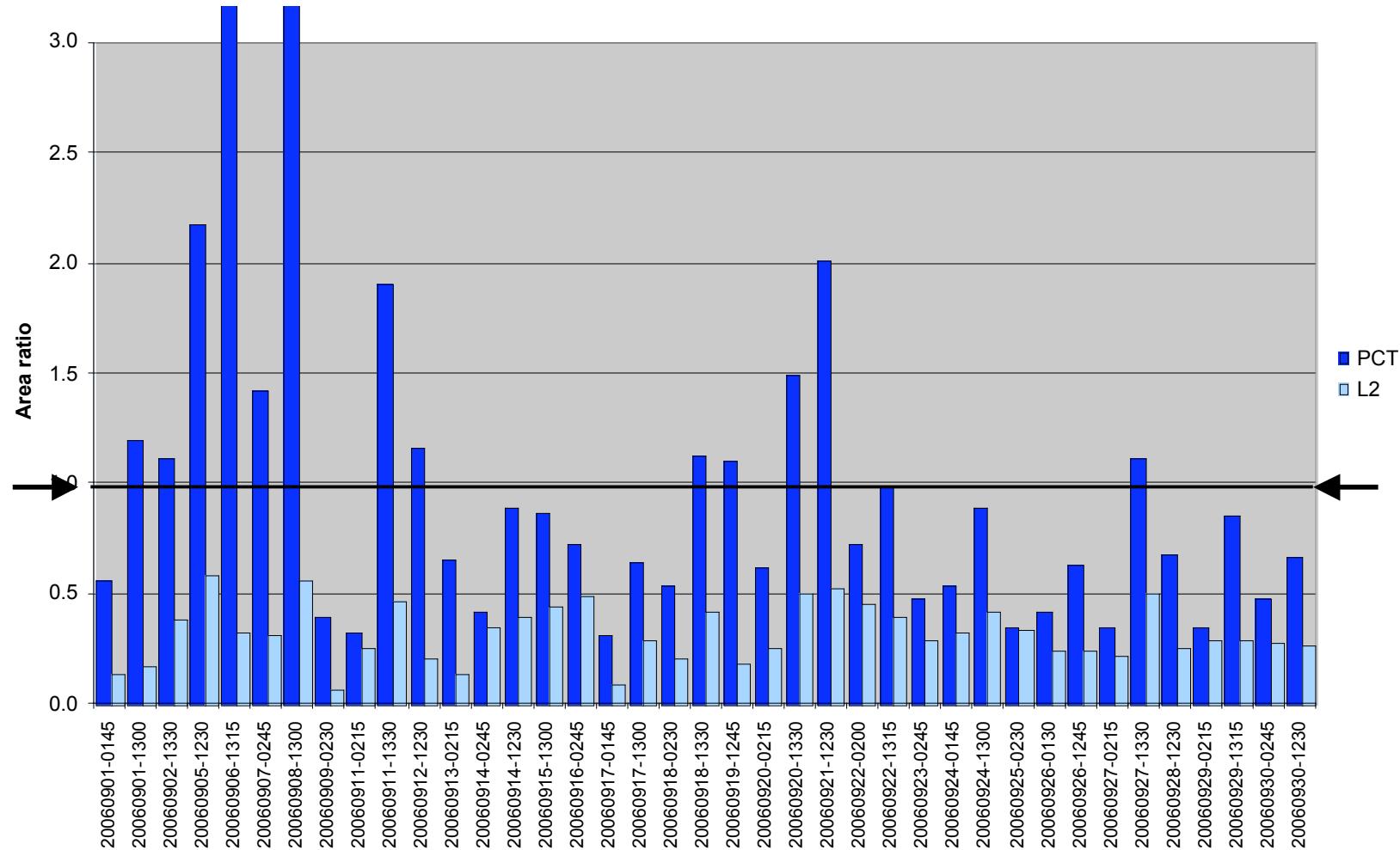
Correlations : instantaneous cases



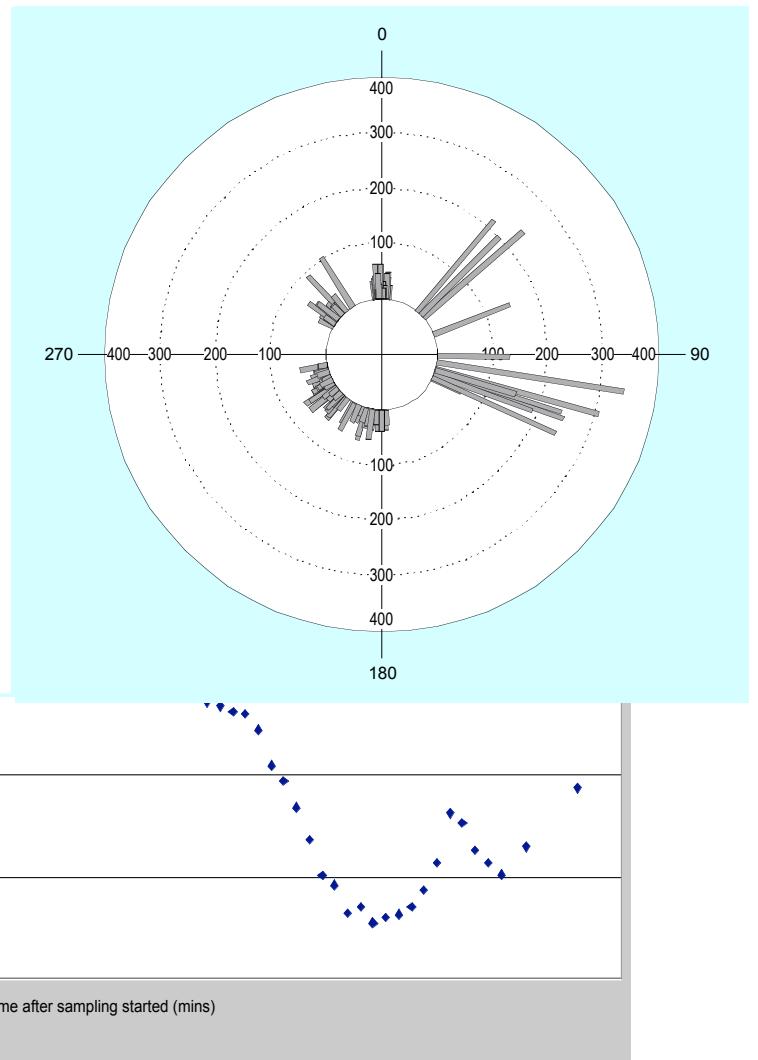
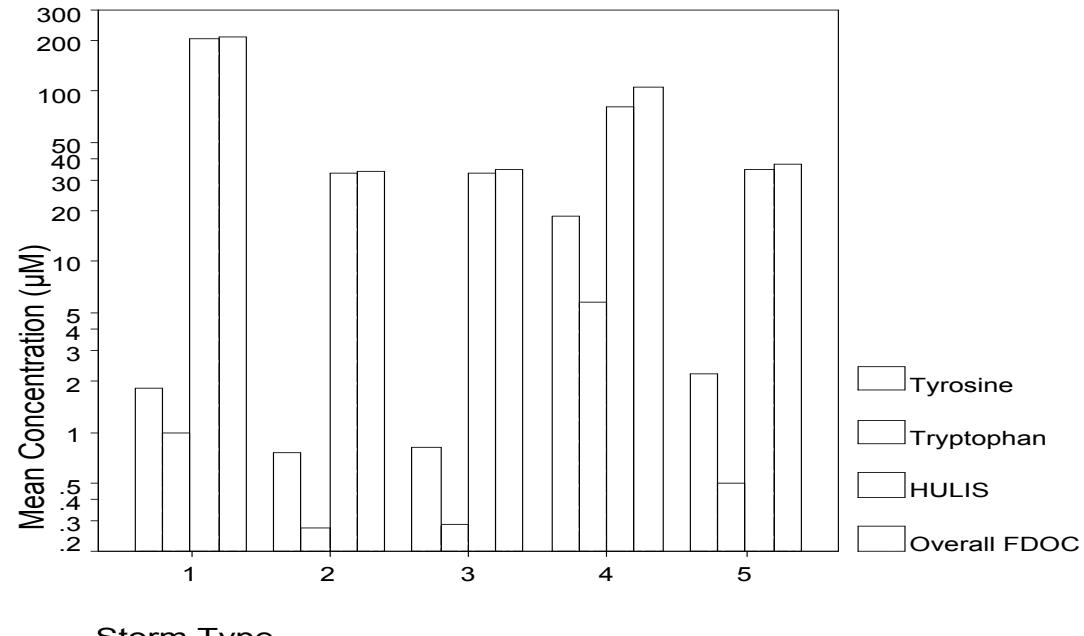
Ratio – accumulation : instan. cases



Ratio – occurrence : instan. cases



Rain is not identical....



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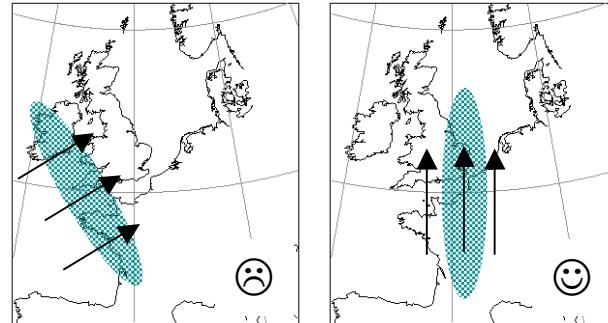
3rd IPWG workshop, Melbourne, Australia. 23-28 October 2006



Statistics: *blame it on the weather!*

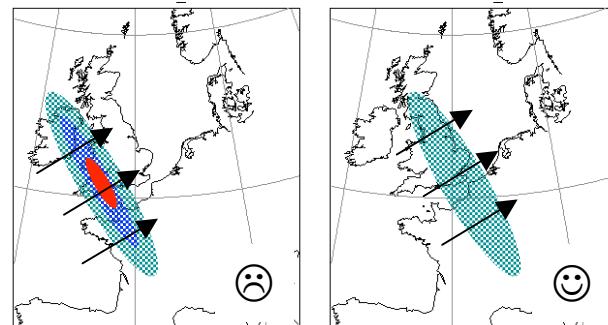
Movement:

Is the movement perpendicular or along the rain band?



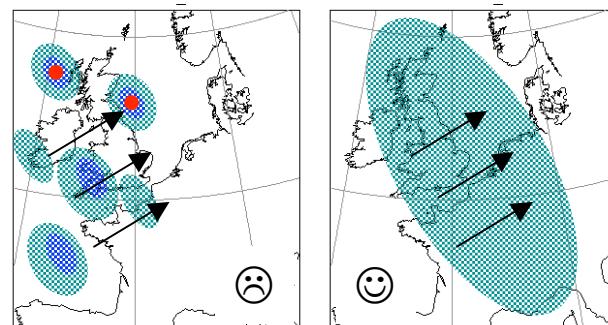
Intensity

What is the range of values within the rain area?



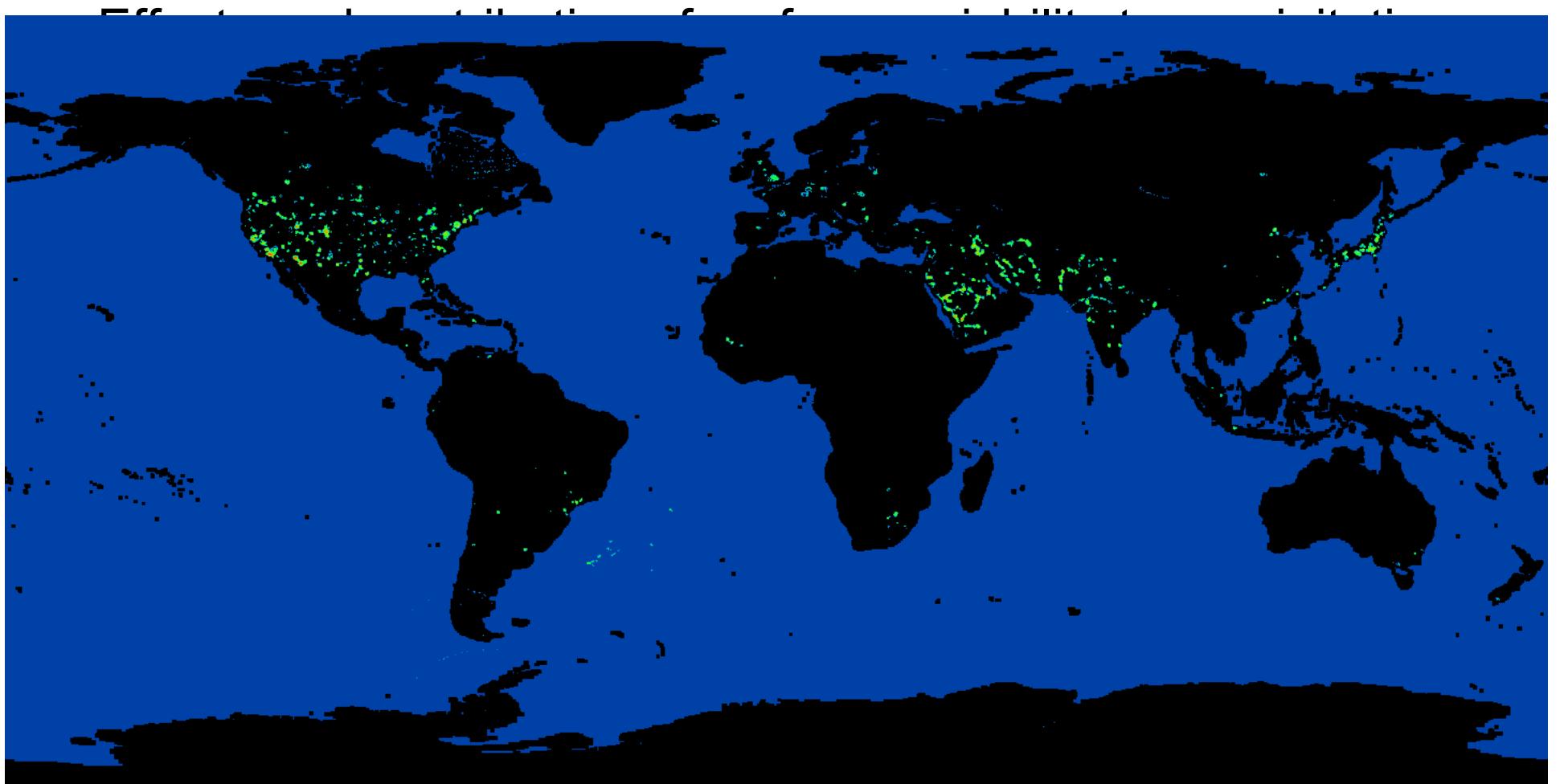
Size/variability

What is the size and variability of the rain area(s)?

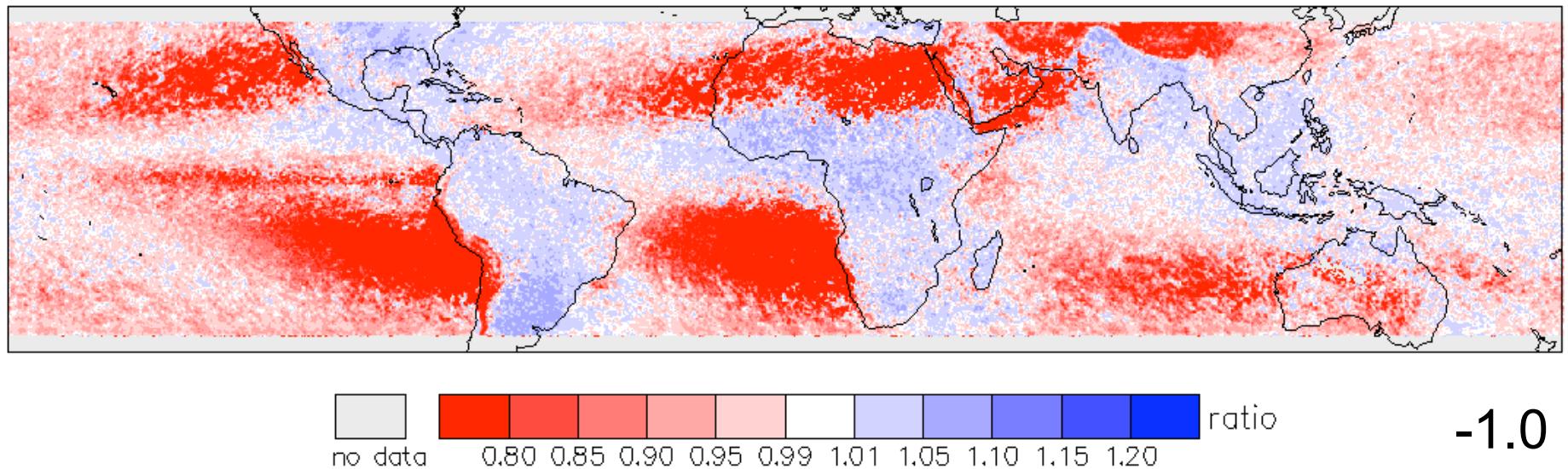


Statistical success has as much to do with meteorology as the algorithms ability...

Surface Variability



Rain/no-rain induced biases



- Differences in rain/no-rain boundaries reveal regional variations that do not exist in reality
- Further complicated since rain/no-rain boundaries tend to differ over land/sea areas

